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The American Congress on Surveying and Mapping is a non-profit association, organized to advance the sciences of surveying and mapping in their several branches, in furtherance of the public welfare and in the interests of both those who use maps and surveys and those who make them. It aims to establish a central source of reference and union for its members, to contribute to public education in the use of surveys and maps, and to encourage the prosecution of basic surveying and mapping programs, especially those programs which are paid for, in whole or in part, with public funds.

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Courtesy Schutz Photographer

PART OF BANQUET HALL—TENTH ANNIVERSARY DINNER
Note the "Countess Maria Pulaski," the first "lady" from the left.

July • August • September • 1950

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Number 3

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The Tenth Anniversary Meeting

THE TENTH ANNIVERSARY MEETING of the American Congress on Surveying and Mapping was held at the Shoreham Hotel in Washington, D. C., June 21–23, 1950. With a total registration of 661, it was by far the most widely attended meeting of the Congress. Membership present represented 23 states of the Union and 24 countries.

The meeting opened at 10 a.m. on Wednesday, June 21, with an address by President Bauer, who reviewed the astonishing progress made by the Congress in such a short time despite many handicaps—not the least of which was the distraction caused by a World War. (President Bauer's remarks are published elsewhere in this issue.)

At the conclusion of his address, President Bauer named a Tellers Committee, composed of Albert C. Kalbfleisch, chairman, and Messrs. Clarence Morris and Julius L. Speert; and a Resolutions Committee, composed of Capt. H. W. Hemple, chairman, and Messrs. Jon Beazley, C. Maltby, Jacob Skop, and M. Delaney.

PRESENTATION OF HONORARY AWARDS

President Bauer introduced Rear Admiral Leo Otis Colbert, recently retired Director of the U. S. Coast and Geodetic Survey, who presented certificates of honorary life memberships in the Congress to Dr. Pedro C. Sanchez, Director of the Pan American Institute of Geography and History; Frederick H. Peters, recently retired Surveyor General of Canada; and to Robert H. Randall, consultant on Surveying and Mapping to the Bureau of the Budget and first president of the Congress, "for outstanding professional contribution to the science of surveying and mapping and for leadership in advancing national and international technical cooperation."

After Mr. Randall accepted his certificate he was recalled to the platform to make a surprise presentation of an Honorary Life Membership to Rear Admiral Colbert, who was visibly moved at receiving the honor.

President Bauer next presented a number of Honorary Citation certificates "for outstanding professional services rendered, without remuneration, to the American Congress on Surveying and Mapping, thereby advancing the aims and purposes of the profession and promoting the public welfare." The recipients of these citations were Ralph Moore Berry, chairman of Exhibits of the Congress and vice chairman of the Property Surveys Division; Walter S. Dix, executive secretary of the Congress; Richard T. Evans, treasurer of the Congress; Dr. Gilbert Grosvenor, president, National Geographic Society; Prof. George H. Harding, first executive secretary of the Congress; Murray Y. Poling, general chairman of the Annual Meeting; Aaron L. Shalowitz, editor-in-chief of SURVEYING AND MAPPING; Dr. John Kirtland Wright, recently retired Director of the American Geographical Society; and, posthumously, to the late Herbert M. Dibert, former secretary-treasurer of the W. & L. E. Gurley Company.

The Wednesday morning session concluded with the introduction of the delegates from the Latin American nations and Canada.

PLENARY SESSIONS

The first part of the afternoon session was presided over by Warren C. Crump, chairman, Technical Division on Cartography. He introduced as the first

speaker Clarence E. Batschelet, chief geographer of the Bureau of the Census, who discussed the importance of maps to the planning of censuses and the depiction of census results. C. S. Spooner, Jr., of the Army Map Service, next covered the new techniques in the making of relief models. He was followed by Jacob Skop of the same organization with a paper on the "Standardization of Maps."

In the absence of William C. Wattles, chairman of the Technical Division on Property Surveys, the second half of the Wednesday afternoon session was presided over by Ralph M. Berry, vice chairman of the division. Prof. G. Brooks Earnest of the Case Institute of Technology began the session with a discussion of "Education for the Land Surveyor." In the absence of the author, Czerny Anderson, a California land surveyor, his paper "Legal Elements of Surveying in the Establishment of Land Surveys" was read by A. L. Shalowitz. The afternoon session closed with an interesting paper on the "Metes and Bounds Location Problems in New England," presented by Gordon E. Ainsworth, registered land surveyor of South Deerfield, Mass.

Thursday morning's meeting began with C. S. Maltby, chairman, Technical Division on Topographic Surveying and Mapping, in the chair. He introduced the three speakers, who discussed topographic mapping activities: Lloyd E. Marsden of the Geological Survey from Rolla, Mo.; Jasper E. King of the Forest Service; and the Honorable George W. Malone, senator from Nevada. Senator Malone discussed "Topographic Mapping Legislation in Congress" and introduced numerous observations on surveying and conservation problems, notably in the Western States.

The last portion of the morning program was turned over to our good friends and neighbors from the north, the Canadians. C. C. Lindsay, registered surveyor and civil engineer of Montreal, introduced the speakers, the first of whom was W. H. Miller, Director of the Surveys and Mapping Branch, Department of Mines and Technical Surveys of Canada, who described the organization and activities of that mapping agency. Lt. Col. C. H. Smith of the Military Survey then spoke on the control problems of topographic mapping in the northern portion of the continent. The final paper by C. H. Ney of the Canadian Geodetic Survey, read by W. Humphreys, was entitled: "A Canadian Geodesist Looks at the Stars."

The first portion of the afternoon session was presided over by L. C. Higbee, chairman, Technical Division on Surveying Instruments. The first speaker was Lester E. Demler, of Wallace and Tiernan, who discussed "Altimetry—Its Present Day Techniques." He was followed by Prof. George H. Harding, of Ohio State University, who spoke on "A Possible Solution to the Problem of Surveying and Mapping Education." The last paper, "What Should Surveying Instrument Specifications Contain?" was presented by Dr. Irvine C. Gardner of the National Bureau of Standards.

At the conclusion of the instrument session Col. Floyd W. Hough, chairman, Technical Division on Control Surveys, succeeded as presiding officer. The first speaker he introduced was Homer C. Fuller, of the Army Map Service, who discussed "An Index of Horizontal Control in North America." William B. Hoke, of the Public Works Department of Baltimore, next presented a paper on "A Half Century of Providing City Control." More control problems were discussed by Pace Hopkins of Maddox and Hopkins of Silver Spring, Md., and the final talk was given by Walter C. Stoneman of the Inter-American Geodetic Sur-

vey, who told of the progress made in hemispherical cooperation.

The first portion of the Friday morning session was devoted to meetings of the various technical divisions. This was followed by a business meeting of the Congress.

In the absence of Dr. John K. Wright, the Friday afternoon session was presided over by Prof. George H. Harding. W. L. G. Joerg, chief of the Cartographic Records Branch of the National Archives, gave an interesting historical account of 175 years of the official mapping of the United States. A talk by Lt. Col. R. W. Philbrick of the Photographic Laboratories of the Army Air Forces followed in which he stressed the importance of research for Air Force cartographic requirements. "New Astronomical Aspects of Mapping and Charting" were then explained by Dr. Allen J. Hynek of Ohio State University.

The presentation of the formal papers was interrupted to allow Dr. André Simonpietri, secretary, Commission on Cartography, Pan American Institute of Geography and History, to introduce Gen. Miguel Sanchez Lamego, of Mexico, who addressed the Congress in Spanish, his remarks being later translated by Dr. Simonpietri.

The final speakers were Dr. Duncan MacDonald, of Boston University, who discussed the role of research in mapping and charting; Dr. Wallace J. Eckert, of the International Business Machines Corporation, who spoke on electronic calculators; and Lt. Gen. W. D. Crittenberger, chairman, Inter-American Defense Board, who pointed out the importance of mapping and charting to the defense and development of the Americas.

The concluding talk before President Bauer formally closed the Congress was the acceptance address by the president elect, Col. Gerald FitzGerald.

In bringing the Tenth Anniversary Meeting to a close, President Bauer made a few brief "state of the Congress" remarks in which he reviewed the progress made in the attainment of the aims and objectives of the organization and praised those who have been outstanding in their efforts to promote those achievements. "If I were a physician and were asked to diagnose the state of health of the Congress as of this date," Mr. Bauer said in closing, "I would say that the Congress has a strong pulse, a good heart, and sound lungs. It has youth, energy, and vigor. At the same time, it gives evidence of rather mature judgment. It is my hope that 10, 15, or even 20 years from this date the diagnosis of the Congress will be the same."

Just before the meeting ended a message from Mayor William O'Dwyer was read inviting the Congress to hold its next annual meeting in New York City.

BUSINESS MEETING

Following President Bauer's opening remarks on progress and plans for the year, the tellers report was read. The following officers and directors were elected for 1951: President, Gerald FitzGerald, chief topographic engineer, U. S. Geological Survey; vice-president, Warren C. Crump, deputy chief engineer, U. S. Hydrographic Office; director for Property Surveys, William C. Wattles; director for Topographic Surveys and Mapping, Arthur W. Kendall; director for Control Surveys, Lansing G. Simmons; director for Surveying Instruments, Louis H. Berger; director for Construction Surveys, William T. Pryor.

Reports for the year were then presented by the officers of the Congress and the various technical divisions and committee chairmen. Some of these reports

appear elsewhere in this issue, others will be published in future issues.

In his closing remarks Mr. Bauer reported that the Congress was now incorporated under the laws of the District of Columbia and that it had been accepted as an active participant in the National Research Council.

STAG-SMOKER

This get-together or good-fellowship hour, on Wednesday evening, held in the Louis Seize Room, was, in the opinion of most, much too short! Afterwards, however, many continued it on the beautiful Shoreham terrace, where a block of tables had been reserved for those members of the Congress who wished to dine under the stars.

EVENING DINNER

The Tenth Anniversary Dinner on Thursday night was a grand success with over 300 attending. During the excellent meal there was music by three charming young ladies who are known to Washingtonians as the Candlelight Trio. They were followed by the Melodaires, a quartet of note, who rendered a number of harmonious selections.

The high light of the occasion, however, was "Countess Maria Pulaski," a Polish noblewoman who escaped the opening debacle of World War II, fled to England and became a member of the British espionage group. Her account of some of her experiences and adventures was almost unbelievable and the thunderous applause she was given was but a small measure of the praise to which "women" of her ability and courage are entitled. L. C. Higbee, her lucky partner at the dinner table, was probably the most envied man at the dinner.

INSTRUMENT EXHIBIT

The Tenth Anniversary Meeting also brought out the largest and finest exhibit of surveying and mapping instruments which has ever been shown to the Congress, and members spent a great deal of time in the examination of some of the new developments in scientific devices which will facilitate their work. The following firms presented exhibits: Aqua Survey and Instrument Co., 2518 Leslie Ave., Norwood, Cincinnati 12, Ohio; C. L. Berger & Sons, Inc., 37 Williams St., Boston 19, Mass.; David White Company, 315 West Court St., Milwaukee 12, Wis.; Eugene Dietzgen Company, 407–10th St., Washington, D. C.; Filotechnica Salmoiraghi, S.p.A., Milan, Italy, represented by Trans-Global Co., 1480 Broadway, New York 18, N. Y.; Henry Wild Surveying Instruments Supply Company of America, Inc., 26 Court St., Brooklyn 2, N. Y.; Hilger & Watts Ltd. (Watts Div.), London, England, represented by Jarrell-Ash Co., 165 Newberry St., Boston 16, Mass.; Kern and Company, Aaray, Switzerland, represented by H. S. Wahlen, 815 Edinburgh St., San Mateo, Calif.; Keuffel & Esser Company, Adams & Third Sts., Hoboken, N. J.; Marchant Calculating Machine Co., 1412 I St., N.W., Washington, D. C.; Officine Galileo, Milan, Italy, represented by Opplem Company, 352 Fourth Ave., New York 10, N. Y.; Otto Fennel Sohne, Kassel, Germany, represented by Norbery Dienstfrey, 478 Water St., New York 2, N. Y.; Raytheon Manufacturing Co., Submarine Signal Division, Waltham 54, Mass.; Sokkisha, Japan, represented by Opplem Company, 352 Fourth Ave., New York 10, N. Y.; W. & L. E. Gurley, Troy, N. Y.; and Wallace & Tiernan Products, Inc., Belleville 9, N. J.

Also on exhibition was a display of instruments and techniques by the Engineer Research and Development Laboratories, Corps of Engineers, Fort Belvoir, Va.; and a selection of historical maps of the United States presented by the Cartographic Records Branch, National Archives, which served to illustrate the paper presented by W. L. G. Joerg, chief of the Branch.

All those who attended the Tenth Anniversary Meeting were pleased to receive a "Romance Map of Washington" through the compliments of Rand, McNally & Company.

—HELMUTH BAY

* * *

Maryland Opens Bureau of Control Surveys and Maps

A BUREAU OF CONTROL SURVEYS AND MAPS, designed to meet the need of engineers for a central office where information and assistance on surveys and mapping can be secured, has recently been opened by the State of Maryland.

The Bureau, previously operated for a brief period during 1939 and closed during the war, is at present drawing up plans to accomplish as economically as possible the objectives set forth in the Act of 1939 which authorized its formation. In accordance with this, the office is attempting to select those lines of endeavor which will best satisfy the most pressing needs. The entire engineering profession should be interested in making this Bureau as effective as possible in bringing about the economies which may be secured through coordination of effort in the field of surveying and mapping.

Mr. W. L. Shoemaker is assigned to the operation of the office, which is located in Room 312 Tower Building, Baltimore Street and Guilford Avenue, Baltimore, Md.

* * *

Perspective Drawing Device

A NEW draftsman's instrument makes it comparatively simple to create perspective drawings. The Perspect-O-Metric, available for attachment to any standard drafting machine or parallel ruling straight edges, automatically guides the draftsman's pencil toward established vanishing point from any position on the drawing board. The device provides for two vanishing points which can be located at any position along the edges of the drawing board.

An ingenious system of graduation is designed to keep dimensions always in proportion, despite apparent reduction in size with distance. Manufactured by Charles Bruning Co., Inc., 4754 Montrose Ave., Chicago 41.—*Engineering News-Record*, July 14, 1949.

President Bauer's Opening Remarks

(Presented at Tenth Anniversary Meeting, June 21, 1950)

LADIES AND GENTLEMEN, may I as president of the American Congress on Surveying and Mapping welcome you to this Tenth Anniversary Meeting.

Measured in terms of the age of most national societies, the Congress is in its infancy, but in spite of its tender age and in spite of a long war that intervened shortly after the inception of this Congress, the Congress nevertheless has achieved a recognition nationally and even internationally that generally comes to a society only in its more venerable years.

I might point out a few of the marks of recognition that have been achieved by the Congress. We have been invited guests to several international meetings on surveying and mapping matters, having been represented at the Pan American Institute of Geography and History, United Nations, Biennial Conference of the United Kingdom, as well as at meetings in our very good neighbor country, Canada.

I am proud to announce that recently the Congress was accepted as a constituent member of the National Research Council in the Division of Geology and Geography.

The mail that comes to the offices of the Congress frequently contains requests for information on matters of surveying and mapping from all parts of the world. In fact, the Congress has membership in every state of the Union and about 50 foreign countries.

Now, why should so young an organization have achieved these indications of national and international respect? In my opinion, there are two principal reasons for this phenomenon. One, I sincerely believe that the Congress in its short life has rendered a good service to the profession. But, two—and at least as important as number one—I think the fact is that an organization such as the American Congress on Surveying and Mapping has been sorely needed these many years, and that with its inception and with its indication of willingness and ability to do a job, there automatically followed the responsibilities and recognition that had been waiting many years for any organization devoted exclusively to the promotion of the professions of surveying and mapping.

The recognition we have already achieved placed upon us the responsibility of ever-increasing effort and further accomplishment toward the betterment of our profession, increased recognition of the profession for its contribution to the scheme of things, and the development within our own fellow workers of a sense of professional responsibility and public duty, without which no profession can long claim respect.

Surveying and mapping in the United States have too long been separate, even diverse, entities. Too long have there been one group called geodesists, another group called topographers, another group called property or land surveyors, each more or less antagonistic or at least suspicious of the other. If the Congress has done nothing else, it has well warranted its experience in having brought together the topographers, the geodesists, the photogrammetrists, the land surveyors, in the same journal, yes, even in the same room, and has actually created a single profession of surveying and mapping, with topography, photogrammetry, land surveys, and many other forms of development and mapping

all part and parcel of techniques to be used as best applied toward the end of better surveys and better maps.

Concurrent with the short life of the Congress is an ever-increasing realization, not only of the need of a vastly greater number of kinds of maps, charts, and surveys, but a continually increasing realization that the order of accuracies that only recently were considered entirely adequate in many fields are now proving to be not only inadequate but very uneconomical.

A publication, resulting from a meeting sponsored by the United Nations at Lake Success on surveying and mapping, at which the Congress was ably represented by past president Marshall Wright, opens with a statement worded somewhat like this: "No planning, whether social, economic, or physical, can be intelligently begun without adequate maps."

The Congress, therefore, stands at a point that allows it no alternative but to carry on with increasing vigor the duties and obligations which it originally assumed, and which have since devolved upon it. Each member of the Congress, therefore, must consider himself a committee of one to develop to the maximum of his ability the aims and purposes of the Congress.

The duties of the president of the Congress make his job no easy one. The correspondence alone involved in the presidency is quite enormous. The same, of course, also applies to the other officers. But the problem of being president, which I personally know, while at the same time trying to make my living as a property surveyor—a profession whose returns are best expressed in terms other than dollars—is a difficult combination. But I can honestly say that the rewards of the presidency are well worth the effort.

The principal reward that I have experienced has been the type of letters that I have received on many occasions since I have been president from men who recently became acquainted with the Congress, men who sent in applications for membership, together with letters that read more or less like this: "All of my mature life I have been looking for just such an organization. May I join? How can I help?"

Such letters are very rewarding, and the feeling that the Congress is accomplishing something for our very old, but at the same time always new, profession is in itself rewarding. May I say that similar rewards await each and every Congress member who has the energy and urge to devote some small part of his time to some phase of the work of the American Congress on Surveying and Mapping.

❦ ❦ ❦

NEW COURSES IN GEODETIC ENGINEERING

Two new graduate courses in geodetic engineering are now being offered by the Civil Engineering Department of the University of Illinois.

The first of these courses deals with the principles and practice of precise triangulation, traverse, and levels. The second course comprises a study of the astronomic determination of latitude, longitude, and azimuth; systems of plane coordinates; map projections; and electronic and special control surveys. The Surveying Division of the Civil Engineering Department is well equipped with the necessary instruments to implement this instruction in geodetic engineering.

The Influence of Electronics on Surveying and Mapping

By COMMANDER CARL I. ASLAKSON
U. S. COAST AND GEODETIC SURVEY

SCIENCE and engineering always advance during wartime, and this was particularly true during World War II. As a result of the development of blind-bombing techniques, the entire field of surveying and mapping is undergoing a "face lifting." The surveyor has discovered that he has a new yardstick at his disposal, namely, the velocity of propagation of radio and light waves, and that an instrument using that yardstick can be designed to reduce the cost of surveys and even to accomplish surveys heretofore impossible with conventional methods.

All of the instruments that have been developed or are under development need not be named and described here. There are many and their uses are diverse. They may be generally classified into three groups, depending on their principal usefulness in surveying. Certainly, however, some of these instruments will ultimately be used in more ways than are now envisaged.

Electronic survey instruments may be generally classified according to their range and probable uses, as indicated in Table 1.

TABLE 1.—*Range and Uses of Electronic Surveying Instruments*

Classification	*Distance*	*Purposes*
Long range	100–2000 miles	Sea or air navigation.
Intermediate range	50–500 miles	Geodetic control. Photogrammetric control. Short-range airplane navigation.
Short range	0–25 miles	Precise distance measurement. Topographic surveying.

Before elaborating on the various classifications, attention must be called to certain facts which prevent the development of an all-purpose system. For long range, the longer waves, which diffract more and therefore closely follow the curvature of the earth, must be used. Range then becomes a function of power output and can be very great. But as wave length increases, accuracy decreases. Several factors contribute to this loss in accuracy, the most important one being an effective velocity change along the path. This velocity change is caused by changes in the conductivity and resistivity of the terrain over which the wave is passing and by meteorological changes along the path. Loran is an example of long-range instruments. It is an effective and important sea- and air-navigation instrument, but its low frequency, necessary for long range, curtails its accuracy and prevents its use for precise surveying. Decca and Electronic Position Indicator (E.P.I.) are also excellent hydrographic surveying instruments; but, since they employ the longer waves, they are unsuitable for geodetic surveying.

The intermediate-range instruments employ intermediate wave lengths, whose paths do not curve so much but nearly follow the path of light itself, or "line of sight." Therefore, such instruments must be used on high elevations

with no obstructions between them, or they must be installed in airplanes to give the necessary elevation to clear the line of sight.

The short-range instruments incorporate very short waves (or high frequencies), usually in the infrared band of light or even visual light. These high frequencies still further limit the range and applications of the instruments; for, while the intermediate frequencies will penetrate haze and fog, the very short range instruments must be employed under visibility conditions very similar to those required for a theodolite.

In all electronic distance-measuring equipment, the instrument must be designed for a constant velocity of propagation of electromagnetic waves. The velocity of these waves is generally accepted to be a constant in a vacuum, irrespective of the frequency. Unfortunately, however, our measurements must be made in air rather than in a vacuum. Radio or light waves traveling through air do change in velocity. These changes are a function of pressure, temperature, and humidity of the air. This is evidenced by the changing refraction, or bending of the rays with changes in atmospheric conditions. Empirical relationships have been developed for refraction in terms of pressure, temperature, and humidity, and it is possible to apply velocity corrections if we can observe the atmospheric changes. The problem becomes more involved with increase in range and with measurements from an airplane, where the velocity changes with altitude. Unusual care is therefore required to determine a velocity correction which is sufficiently accurate for geodetic surveying. Nevertheless, these difficulties are not insurmountable, as experimental projects using Shoran have shown. In those projects an additional "weather airplane" was used to observe atmospheric conditions at the same time as the distances were measured. Another, earlier approach was to make use of radiosonde or weather balloon reports made by the Weather Bureau and attempt to assess meteorological effects from carefully drawn weather maps. Still a third, but less accurate approach is the use of an "average velocity" for the area being surveyed.

When radio waves approach in length those of the broadcast band, they bend more, and their effective velocity is slower. The "surface wave" used in the longer range instruments, such as Loran, E.P.I., and Decca, curves over the surface of the earth and, as previously stated, is affected by the type of terrain over which it passes. A somewhat crude analogy is to say that the velocity of the ground wave is lowered by friction as it passes over the surface of the earth. Technically, it is said that the "phase velocity" also changes. Since this effect is very difficult to evaluate and correct for, it will always limit the accuracy of long-wave instruments.

In the short-wave, or high-frequency, band, which is used in Shoran, or when light itself is used, the ground effect is negligible. But when very high frequencies such as light travel in air, there is a scattering or "dispersion" because changes with frequency occur in these bands. Consequently, the velocity correction must take into consideration the color, or frequency, of the light. Over the short distances measured with instruments which use light itself, this is not difficult to accomplish, if justified by the measuring accuracy of the particular instrument.

This paper is limited to the use of electronics in surveying and mapping, and therefore only intermediate- and short-range instruments will be discussed.

Before proceeding with this discussion, one more point requires clarification. So far as we can foresee now, electronic equipment designed for accurate surveys

must be limited to distance measurement. This is because reflectors or directive antennas apparently cannot be designed to narrow a beam sufficiently for an accurate determination of direction. Nevertheless, directions have been measured to about 30 seconds of arc with at least one instrument which will be mentioned below. Electronics may, therefore, play an important part in topographic surveying.

INTERMEDIATE-RANGE INSTRUMENTS

The Shoran project in the Caribbean (where 47 lines varied in length from 67 to 367 miles), which was carried out by the U. S. Air Forces in 1947 under the direction of the writer, is the most extensive test to date of the use of electronics for geodetic surveying. As a preliminary test of instruments and techniques, it was highly successful.

The tests were based on the principle that the minimum sum distance between an airplane and two ground stations can be computed from distances observed at regular intervals as the airplane is flown *across the line between the stations.* When the altitudes of the airplane and ground stations are known, the two *air to ground* distances can then be reduced mathematically to a single sea-level distance joining the two stations. Other important corrections were applied, but it is beyond the scope of this paper to describe them in detail. They consisted of instrumental corrections derived by calibration, an empirical correction due to an error caused by varying signal intensities, and a correction for the variation of the velocity of radio waves with changes in meteorological conditions along the ray path.

Although the final accuracy of the Caribbean trilateration was evaluated as second order, that figure is somewhat improved if the rate for the basic velocity of electromagnetic waves in vacuo is increased slightly. The writer, on the basis of project results, showed that the presently accepted velocity appears to be too low by about 16 kilometers per second. Recently, two European observers, using entirely different methods, have also indicated that this may be true.

The success of the Caribbean project resulted in the organization of Shoran geodetic and photogrammetric organizations by the Canadian and Australian Governments. The British also developed methods of using G-H and Oboe for photogrammetry with encouraging success.

Even while the war was in progress, the U. S. Coast and Geodetic Survey (USC&GS) took steps to utilize Shoran for hydrographic surveying. This application was successful from the outset. At present the only reason its use has not become general for all hydrographic parties is the lack of equipment.

The limited range of Shoran when used on ships and launches caused the Coast and Geodetic Survey to develop E.P.I. This instrument is designed to use a frequency of 1850 kilocycles per second, and hence the surface wave can be used for distance measurement. It employs pulse-transmission and phase-shifting techniques.

Tests extending over three seasons on the USC&GS ship *Hydrographer* have proved the value of E.P.I. Although its low frequency of 1850 kilocycles prevents an accuracy comparable with Shoran, it has been used successfully to position a ship more than a 100 miles off shore, far beyond the Shoran range. All survey vessels engaged in offshore surveys beyond the Shoran range will eventually be equipped with E.P.I.

An important point to remember is that Shoran, as tested for surveying, was

a modified bombing instrument. Without question, application of the same methods with an instrument designed specifically for surveying could achieve better results.

The accuracy of Shoran suggested its use for controlling individual aerial photographs. In this respect, important advances have been made, but more research is necessary. Shoran-controlled photography is advancing rapidly. Of particular importance to the photogrammetrist is an auxiliary instrument, the Shoran straight-line indicator. By means of this instrument, the pilot can fly straight lines with minimum side lap. Map or dead-reckoning navigation is not needed. The straight-line indicator is simple in construction and operation. It may be briefly described as follows:

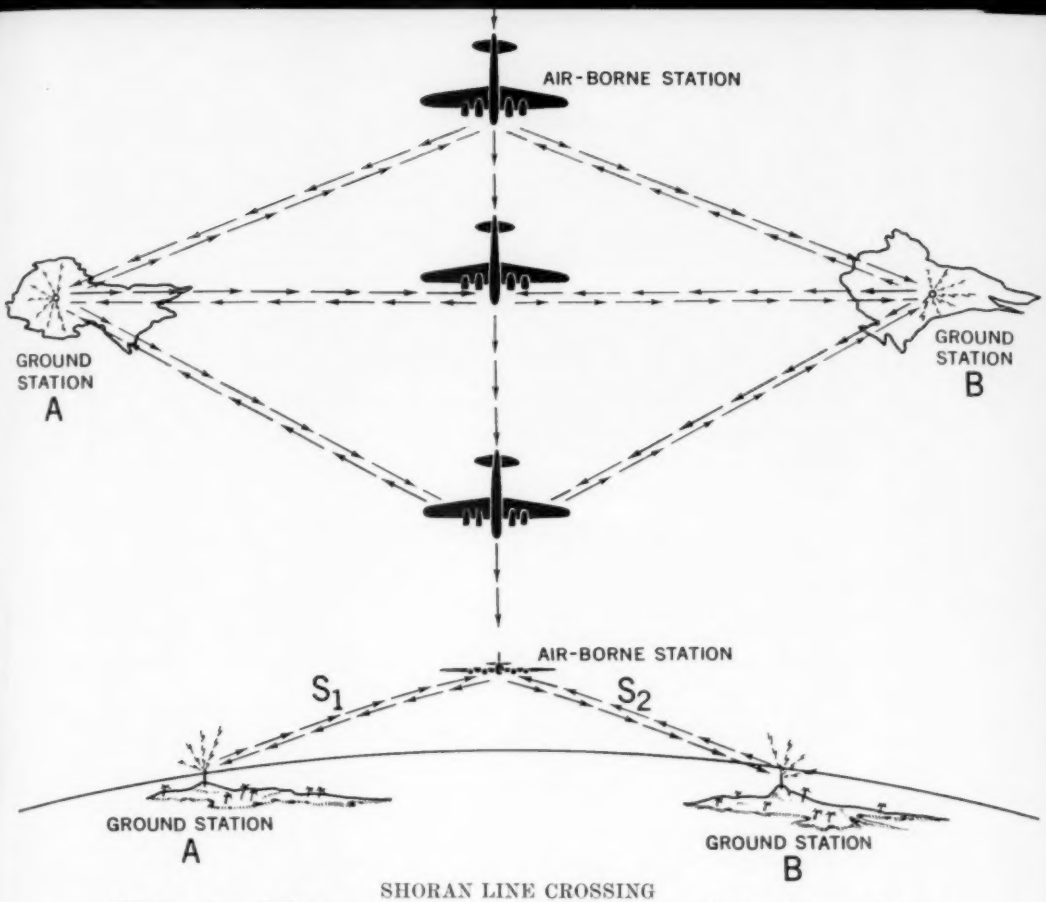
A small plotting board at a scale of 1:1,000,000 contains two "ground stations" from which two long threaded arms emanate. These "ground stations" are adjusted to the approximate ground distance between the actual stations, and the threaded arms are joined together in a "bug," which represents the airplane. The changing Shoran distances cause the threaded arms to move in or out along their length, thus moving the "bug." The latter is placed on a track along the line to be flown. When the distances to the ground stations change at a rate which causes the airplane to leave the predetermined flight line along which the fiducial edge of the track is placed, a mechanical movement of a lever arm changes a resistance. The dial indicating this varying resistance is calibrated in feet to read instantaneously the distance and direction of the airplane from either side of the predetermined flight line. This information is also transmitted to the pilot by means of a Pilot Direction Indicator, or P.D.I., which shows airplane deviations of as little as 25 feet from the flight line. When on a flight line the pilot merely keeps the P.D.I. needle centered in order to stay on line, provided the Shoran pips are kept in continual coincidence. In practice, the pilot uses the automatic pilot to remain on the flight line, while the co-pilot maintains a constant flight level with the elevator controls of the automatic pilot. By means of this instrument, nearly perfect flight lines can be flown without reference to the ground. On large projects in unmapped country, Shoran straight-line-indicator navigation will probably pay for the additional cost of Shoran equipment and operation by savings in excessive overlap and in the fewer reflights needed.

SHORT-RANGE ELECTRONIC INSTRUMENTS

During the advances in electronic surveying methods, the needs of the ground surveyor have not been neglected. Numerous developments have indicated that our old traverse, triangulation, and topographic techniques must be modified to keep pace with the times.

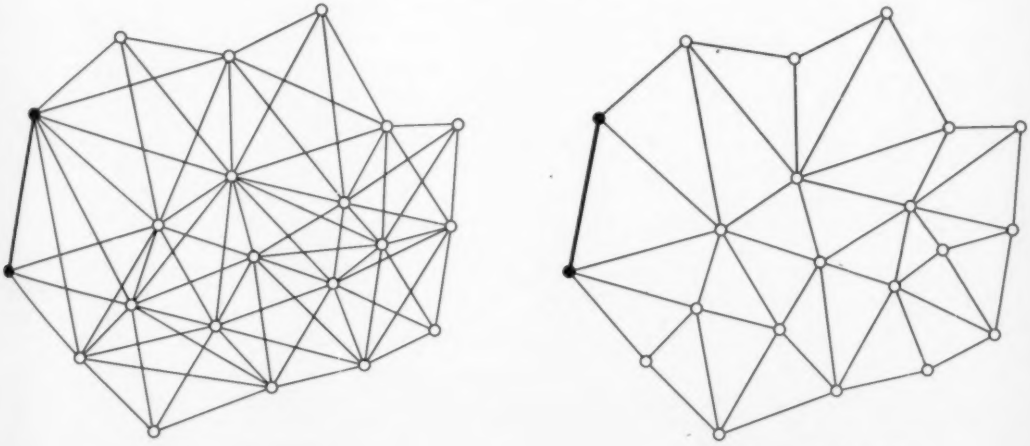
A notable advance in short distance measurements has been made in Sweden. The Bergstrand "Geodimeter" is reported to have proved highly successful in a series of tests. The Geodimeter employs light rays in measuring the distance between the observer and a plane mirror which is located at the target point. In addition, it is said to be easily portable.

The reported accuracy of the Geodimeter is very high. Correspondence and reports state that distances up to 30 kms. can be measured with an accuracy exceeding 1 part in 300,000. It is also reported that the instrument can replace invar tapes in measuring bases except where the latter are needed to calibrate the Geodimeter. Measurements over varying invar-taped distances have indi-



SHORAN LINE CROSSING

Minimum sum of distances S_1 and S_2 occurs when aircraft is on line joining ground stations A and B. Minimum distances are separately reduced to sea level, then added to obtain geodetic distance between ground stations.



SHORAN TRIANGULATION
Observed lines: 73
Geometrical conditions: 35

VISUAL TRIANGULATION
Observed lines: 46
Geometrical conditions: 35

COMPARISON OF SHORAN WITH VISUAL TRIANGULATION

cated that the velocity of light can be measured by the Geodimeter, and the latest report of these measurements gives a velocity of 299,792.7 ± 0.25 km./sec. of light in vacuo. This agrees closely with the value of 299,792.3 deduced by this writer from Shoran measurements and by Essen, who used an entirely different technique.

Bergstrand reports that observations with the Geodimeter must be made under conditions similar to those needed for triangulation observations. Observing time for a single observation is about 2 hours. An additional 2 hours is required for the computation.

The requirements of the topographic engineer are not being neglected in the electronic surveying field. Under the auspices of the Engineer Research and Development Board, an electro-optical surveying system is being developed with which distances up to about 3 miles have been measured with an accuracy of 1 : 2,500. This instrument also measures azimuths with an accuracy of about 30 seconds of arc. Vertical directions can be observed with similar accuracy. Observers who have seen these tests report that the system shows great promise. Although it is doubtful that the accuracy of angle measurement can be greatly improved, the accuracy of distance measurements will undoubtedly be increased.

Our old, established concepts of surveying are evidently undergoing a radical modification. Let us examine in greater detail the influence the new instruments will have on some of our surveying and mapping techniques.

Before describing the influence of electronics on particular surveying techniques, there are two peculiar features of electronic surveying instruments which should be understood.

(1) Errors of electronic surveying instruments are nearly independent of the distance measured.

(2) Any single measurement is a unit measurement.

The above two features are interrelated and must be considered together. The design principle of all electronic surveying equipment is such that its operation is equivalent to a surveyor using a tape of varying length but with the same error irrespective of the length. If he wishes to measure a distance 200 meters long, he adjusts his tape to that distance. If he wishes to measure a 10-mile distance, he stretches his tape to that length, but the error of measurement remains the same. Therefore, the *proportional* errors grow smaller with an increase in the distance measured.

The fact that any single measurement is a unit measurement enables the surveyor to determine constant errors in his equipment. For example, when a line 20 miles long is measured once between its two ends and again in two sections of 12 and 8 miles each, with an instrumental error of + .001 mile in each case, the result of the 20-mile measurement will be 20.001 miles while the two short measurements will be 12.001 miles and 8.001 miles. It is clear that the correction resulting from a constant error in the equipment is equal to the *difference between the long measurement and the sum of the two short measurements,* or 20.001–(12.001 + 8.001) = – .001 mile. Because of this unique feature, valuable checks on field measurements are possible.

ELECTRONIC APPLICATIONS IN GEODESY

In geodetic surveys accurate measurements of distances up to 500 miles will enable us to make surveys heretofore impossible. We can connect continents

and make interisland connections. We can determine a world-wide datum and an improved figure of the earth.

For example, consider the Amazon River Basin. An arc of Shoran triangulation can be carried from coast to coast through the Amazon jungles *in less than one year* with an organization equivalent to the one which completed the Caribbean tests. Moderate-sized amphibian planes are the only transportation needed for the ground station equipment, and a number of airfields are available for the Shoran planes. The spacing of these stations would be at 50- to 400-mile intervals but that spacing is sufficient for controlling surveys needed for maps of scales as large as 1:50,000. The cost of such control probably *would be less than $1.00 per square mile.*

Let us consider the applications of the Geodimeter and similar instruments. Our present concepts of "strength of figure" must be greatly modified. No longer do we need to locate stations at points difficult of access in order to maintain "strength of figure." One example is in a river survey where the river is confined by fairly steep banks. A scheme of narrow figures which are long in the direction of progress can be carried up such a river with one long side in each figure being measured by the Geodimeter. In this manner, the azimuth can be accurately carried through the measured directions while the Geodimeter distances are held fixed as bases in each figure. In triangulation of this nature all of the stations established are on or near the river banks where they will be of most value to the engineer. If the rivers are navigable, the problems of transportation are greatly simplified.

The word "trilateration" will assume equal importance with triangulation. As a result, the surveyor will deliberately incorporate long, thin, or "sliver," triangles into many of our trilateration schemes. Such triangles are avoided in conventional triangulation, for they add little strength to the figure. In electronic trilateration they are required, because their incorporation will help to reveal constant errors in the least-square adjustment process.

Cities are rapidly becoming aware of the importance of precise geodetic control. Accurate electronic trilateration will be very useful in such surveys. It will be equivalent to having a network of first-order bases covering an entire city, the whole scheme accurately oriented by theodolite angles. A least-square adjustment of such a network can certainly be presumed to have a very small error indeed.

In all short-line ground triangulation schemes, bases will be more frequent and *base expansion networks will be eliminated.* The cost of a base 20 miles long will be no greater than a base 4 miles long. The additional cost of the expansion network will be eliminated, and at the same time the accuracy of the network as a whole will be improved.

ELECTRONIC APPLICATIONS IN PHOTOGRAMMETRY

Numerous tests of controlling aerial photographs by Shoran, G-H, and other electronic equipment have been made, and Shoran has actually been used on field projects of considerable extent. The accuracy which can be attained at the present time is slightly less than in surveys completely controlled with conventional ground control; but, to offset this loss in accuracy, we can map areas rapidly which conceivably might not be mapped in the next century by conventional methods. The Engineer Research and Development Board of the Corps

of Engineers have evaluated the accuracy of Shoran-controlled photogrammetry. Their published conclusion is that, in any single 1 in 50,000 quad sheet, the relative accuracy of the distance between two points is about 120 feet and that there is a possible shift of about 40 feet between sheets. This estimate was based on some early Shoran-controlled photography and may be improved by an analysis of more recent work. The British, in a report by C. A. Hart,[1] conclude from experiments with G-H, that "The best results to be expected for computed control points give random errors of the order of $\pm$ 20 meters in range and $\pm$ 10 meters in relative height, the maximum range being 200–250 miles. . . . Although maps at a 1:25,000 to 1:50,000 scale can be made to a reasonable standard of accuracy without direct reference to the ground, mapping to full peacetime specifications requires a small amount of ground control when radar fixes are employed, but on a very much reduced scale."

The writer believes that the above estimates of accuracy will improve with advances in instrumental design and improvements in technique. However, the important question to be answered at present is, "Do we really need the originally specified accuracy in many areas?" and, "Is it better to do without surveys or to relax our specifications slightly?"

ELECTRONICS IN THE DETERMINATION OF ELEVATION

The field of elevation determination by radio altimeter has been explored to some extent by Great Britain, Australia, Canada, and the United States, but much remains to be done. When an airplane is flying at a constant pressure level, the relative change along the flight line between the pressure level and the terrain can be determined within certain limits with present available equipment. As an example of probable present accuracy, the British estimate that the random errors in relative height are about $\pm$ 10 meters. While this accuracy is considerably less than that which can be attained by conventional leveling control, it is certainly great enough to warrant the use of the radio altimeter method in unmapped country.

The writer suggests that another approach to a solution of the problem might prove successful if it is thoroughly explored. This approach would be the establishment of "datum planes" at suitable intervals over the area being surveyed. These datum planes could be lakes, flat plateaus, valleys, or river surfaces which can be recognized in photographs. The airplane would make a number of flights between the datum plane and some known elevation or check point, preferably sea level, the flight between the two points being made at a constant pressure level. Calibrated radio-altimeter readings must be observed at both ends of the flight, thus giving differential readings between the plane and the two points. The constant pressure level is not necessarily a level line but may have an upward or downward gradient. However, when the assumption is made that the wind is geostrophic, this gradient may be computed from certain observable data. These data consist of the true heading, the course made good, the mean latitude, the velocity of the aircraft, and the distance between the observation point and the check point. Using electronic methods such as Shoran, all of the above data can be determined with considerable accuracy. The principal fault of the method lies in the assumption that the wind is geostrophic, but this condition is frequently almost true above certain elevations because the geo-

[1] HART, C. A.: Surveying from Air Photographs Fixed by Remote Radar Control, *Directorate of Military Survey*, War Office, Great Britain.

strophic wind is caused by the earth's rotation and hence is solely a function of latitude. This procedure corresponds to airplane leveling to establish control points or surfaces for the use of the map compiler. When such flights are repeated on different days and under different weather conditions, it seems possible that a sufficiently accurate and well-coordinated series of check points could be established to be useful for control, the gaps between them being bridged by multiplex methods. Comprehensive tests of this system may be initiated by the U.S. Air Forces and by the Canadian Government in the near future.

The Shoran instrument can be used as a radio altimeter when the receiver is tuned to the same frequency as the transmitted signal. A slight modification of the instrument permits this to be done quite readily. The echo pulse then registers on the oscilloscope, and the difference in height between the airplane and the terrain is read directly on the dial, the maximum reading accuracy being .001 mile, or about 5 feet.

An encouraging sign of the interest in electronic altimetry is the fact that commercial organizations are building recording altimeters. Two such instruments have recently been called to the attention of the writer.

The Photographic Survey Corporation, Ltd., of Toronto, Canada, has built an airborne profile recorder for which an accuracy of $\pm$ 10 feet is claimed. Midwest Aerial Surveys recently reported that results of the same order of accuracy were obtained by combining a continuous strip camera which photographed terrain on one half of the film with readings of a barometric altimeter, radio altimeter, and other instruments on the other half. Such private accomplishments in the field of airborne leveling equipment are encouraging, and future progress in electronic leveling will no doubt be rapid.

ELECTRONIC APPLICATIONS IN TOPOGRAPHIC SURVEYS

Photogrammetry now dominates the field of large area mapping, but occasionally small local topographic surveys are undertaken. In such cases the electro-optical system of the Corps of Engineers can play an important role. If one imagines increasing the range of stadia readings to 3 miles and at the same time maintaining 1:2,500 accuracy, one can realize the importance of developments of this nature. When this instrument is used in conjunction with a Geodimeter, extension of topographic surveys over areas of considerable extent may prove to be rapid and cheap.

ELECTRONIC APPLICATIONS IN HYDROGRAPHIC SURVEYS

Little comment is needed on the use of electronics in hydrographic surveys. These surveys were successful from the outset. Shoran was taken into the field for a preliminary test and operated successfully thereafter. At the present time nearly all hydrographic ships and launches of the Coast and Geodetic Survey are provided with this equipment.

Because the use of Shoran is restricted to line-of-sight distances, its range is limited by the height of the ground stations. About 35 miles from shore is an average figure for the Shoran range on hydrographic surveys.

However, beyond the range limit of Shoran, E.P.I. is used. The first model, designed for testing purposes by engineers in the Coast and Geodetic Survey laboratory, was installed on the survey ship *Hydrographer* for a field test. This test was so successful that the instrument was used for an entire season's survey in the Gulf of Mexico. Since that time E.P.I. has been steadily improved and will soon become standard surveying equipment on all vessels of the Survey.

Shoran station set up in truck for calibration.

Erecting antenna for Shoran hydrographic station.

Shoran mast installed on launch.

ELECTRONIC APPLICATIONS IN AIR-PHOTO NAVIGATION

Precise flight-line navigation is always difficult, particularly at high altitudes. The use and facility of operation of the Shoran straight-line indicator have been described. However, Shoran is heavy and costly. Large airplanes are required. The commercial aerial photographic companies need an electronic device which will serve as a navigating instrument but which is smaller and cheaper. Small and inexpensive transponders have been designed for certain anticollision procedure equipment. Such instruments will have errors too great to be used for survey control but should prove satisfactory for flight-line navigation. Costs, including first cost and maintenance, will be low in comparison with the saving in excessive side lap and in reflights due to faulty navigation. It is hoped that such instruments will be modified or redesigned as light, inexpensive, navigation instruments.

ELECTRONIC APPLICATIONS IN GEOPHYSICAL SURVEYING

Geophysical surveying such as seismographic operations is in a class by itself in that duplication of a position is more important than absolute accuracy. Certain electronic instruments such as Lorac possess this attribute. Lorac is similar in principle to the British Decca system but is "nonambiguous." This means that certain large errors which sometimes occur due to malfunctioning of the electronic system, causing what is known as "lane slipping," cannot occur. "Lane slipping" refers to a sudden shift of the true curve of reference by a large amount. It is sometimes said, "You can always locate which pew you are in, but you may be in the wrong church." The "nonambiguous" feature removes this uncertainty; yet changes in the phase velocity of the ground wave as it passes over various types of terrain make precise absolute position determination impossible. Nevertheless, instruments of the continuous wave type can be designed which are light and portable and are therefore useful when duplication of position is of prime importance.

CONCLUSION

Obviously, our present concepts of surveying techniques must be radically modified. Electronic surveying research is expensive, and production of equipment is limited. As a result, research of this nature must be carried on by governmental organizations. Surveying and mapping organizations should therefore support governmental research in electronic surveying. At the same time, they should urge that the instruments so developed be released to private industry for manufacture and sale to the private surveyor. In the end, the final benefits to all surveying and mapping engineers will be very great. The net result of these developments will be faster, better, and cheaper surveys.

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NEW ENGINEERING BUILDING

The University of Tennessee is to be congratulated upon the addition of Perkins Hall to its College of Engineering, dedicated on March 6, 1950, in Knoxville. Dr. N. W. Dougherty, Dean of the College, presented representatives of guest societies who attended.

The American Congress on Surveying and Mapping was represented by William S. Massa of the Tennessee Valley Authority.

The Soil Map—A Modern Engineering Tool

By H. W. WHITLOCK

ENGINEER, IN CHARGE CARTOGRAPHY, DIVISION OF SOIL SURVEY, DEPT. OF AGRICULTURE

BEGINNING in 1899, and each subsequent year, the Congress has authorized the Department of Agriculture to classify and map the soils of the United States and its Territories, and to publish these data in forms useful to the public. The results of these researches and their interpretations are assembled and published, usually by counties, as Soil Surveys, each consisting of a soil map and report.

This research has been under active progress for 50 years. A modest program is going forward throughout most of the country today. It is conducted cooperatively between the Division of Soil Survey of the Bureau of Plant Industry, Soils, and Agricultural Engineering and the State Agricultural Experiment Stations. In addition, other Federal agencies, such as the Soil Conservation Service, the Bureau of Reclamation, and the Tennessee Valley Authority, assist in certain areas where the results are especially critical to their programs.

THE SOIL MAP AND REPORT

The development and interpretation of these soil maps and reports involve an intensive research program in the field and in the laboratory. The characteristics of the soils must be accurately determined from field studies and from the laboratory examination of samples taken from the significant horizons, or layers, of representative soil types. Careful analyses must be made of research results that have been obtained in field plots and other studies which reflect the nature of the individual soils. The whole must be interpreted and an explanatory text prepared for each map. Suitable aerial photographs, horizontal control, and other map information must be obtained. From the field data manuscript maps are constructed, using photogrammetric and other methods. Map copy is prepared for reproduction and the arts of lithography and printing used to reproduce the completed maps and text.

This is not the place to go into the manifold details of soil research and soil classification. These are covered in many texts and handbooks. A little needs to be said, however, about the nature of soil. In various forms, it covers the land surface as a nearly continuous layer. Its characteristics in any one place result from five genetic factors—climate, living matter, relief, parent rock, and time. Besides these, of course, man has influenced some of the natural soils, changing their characteristics.

Now in both research and practice one does not deal with the whole continuum at once. Individuals must be recognized. Scientists do not deal with vegetation as a whole, but with plants. Similarly, they deal with soil types, not with soil in general. Many thousands of soil types exist in the world. In fact, there are as many soil types as there are significant combinations of the five genetic factors. In this sense, as an individual, a soil is a dynamic, three-dimensional piece of landscape. Its upper surface is the surface of the land; its lower surface is defined by the lower limits of biological forces; and its sides are boundaries with other

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kinds of soils where there is a change in one or more significant characteristics.

A soil type has a unique combination of characteristics. Its characteristics are learned through observation in both field and laboratory. Its previous history and its future behavior are disclosed by these characteristics. The influence of any one characteristic, or the significance of a variation in any one—say, texture, depth, color, or structure—depends upon the others in the combination. Thus a system of soil classification comprehends all observable characteristics, not merely a few.

To understand the significance of a particular soil characteristic, the whole combination of characteristics possessed by a soil must be understood. These sets, or combination of characteristics, distinguish the units in soil classification—namely, soil types, soil series, soil families, and so on. The place of an unknown soil in the system, and its relationship to other units, is determined by comparing its set of characteristics with those of the known soils in the system.

The Soil Map

The soil map shows the boundaries of the individual soil types and phases of a particular area in relation to the other prominent natural and cultural features. The accuracy with which soil boundaries are located is determined generally by the intensity of agricultural use and the contrast among the soil types. Among the soil maps published, there is a wide range of accuracy. Many of the earlier ones leave a good deal to be desired, and some of the reconnaissance surveys are generalized. The modern detailed soil survey, however, has a high degree of accuracy at the scale of publication. It gives us the most comprehensive and most accurate map of rural land characteristics and qualities that we have.

Soil types are delineated and designated by symbol. Groups of similar soil types are indicated by color tints. Planimetric detail compares favorably with that of standard topographical quadrangles. Drainage patterns, because of their importance to soil and soil uses, are usually more detailed.

The Soil Report

In the soil report the general setting of the area is described, including climate, physiology, geology, drainage, and land used.

The classification of the soils is presented in the report, together with definitions of all the soil types, soil phases, and other mapping units. It must always be recalled that a proper definition of the soil includes all the material to considerable depth, not just the surface soil. Especially in engineering work, one is concerned with the lower layers, which are often strongly contrasting with one another and with the surface.

The report includes predictions of the yields of crops that may be obtained under different systems of farm management and the effects these practices have on the long-time productivity of the soils.

Predictions of the behavior of soils in respect to construction and other matters of interest to engineers can be made. But these are rarely included in the soil surveys as now published by the Department of Agriculture. Even so, many of the more recent soil reports carry tables giving some of the properties of the soils that are important in engineering. Some of these are drainage, high-water tables, permeability, and underlying geologic material. To date, it has not been

possible to characterize the soils as fully in terms of properties important in engineering as would be desired.

ENGINEERING INTERPRETATIONS

The fundamental value and use of soil classification for engineering interpretations is no different from its use for other interpretations. Field examinations and laboratory tests disclose the nature of the soil and make predictions about its behavior possible. But unless these examinations and tests are related to a comprehensive scheme of classification, their usefulness is limited to the spot where the examination was made and the test sample collected. The fundamental purpose of soil classification is to avoid having to make tests and trials at every point. With the soil classified and mapped, it is possible to make tests to determine soil properties at sample locations and use the result of such tests to predict soil behavior throughout the area where soils are like that of the sample. For example, one may test the corrosion of iron pipe in a particular soil, but unless he has a soil map indicating where similar soil exists, he is under the necessity of making the test everywhere.

Most published soil maps are on scales from 1 : 63,360 to 1 : 15,840. Although these are adequate for practically all farm planning purposes, they are not in sufficient detail for many engineering plans. Still they are very valuable to the engineer. They can be helpful in general planning, in the tentative selection of sites, and in the preliminary analyses of sub-grade problems to be dealt with. For many areas they are the only existing base maps of reasonable accuracy.

To many engineers, at first glance, the soil map may present an intricate and confusing pattern of symbols and boundaries. But those who have studied the soil map and text have been well rewarded. The map gives a composite picture of the landscape and its detailed drainage pattern. The relief and other geomorphological features may be interpreted in considerable detail. It therefore gives the engineer an excellent base for relating the nomenclature of the principal soil types to the general system of classification. Of course, the detailed characteristics of a soil are not shown on the map; it indicates only the names of soil types, which represent sets of characteristics. One must study the report in order to learn the individual characteristics.

As engineering tests of all sorts are made and the results correlated with the system of soil classification, a large body of sound scientific knowledge is developed upon which to base predictions in the engineering field. This work will have to be done largely by the engineers themselves. The Division of Soil Survey has not had the resources to undertake this responsibility. The soil scientists will, however, be glad to make all of the information available and help the engineers in any way they can with the soil classification side of this work.

ENGINEERING USES

Mapping

To the land surveyor, county engineer, or others interested in maps of large areas, the soil map furnishes a base map for a great many uses. As it normally covers a county, it makes an ideal base for plotting land ownership and other information. The cartographer and photogrammetrist will find it an excellent planimetric base for reference, for superimposing other information, or for assembling various types of special maps. As it covers an extensive area, contains a wealth of planimetric detail, and is of reasonable standards of accuracy, it can also serve

many purposes in the mapping office. To the photogrammetric engineers responsible for planning and executing aerial photography, it is valuable as a map for laying out flight lines and estimating costs. It serves the cadastral engineer as a base for planning surveys.

Highways

A recent survey of Highway Departments indicates that 28 states require detailed soil information for the higher type of road construction. It has been found that such information is essential for economical design, construction, and maintenance of this type of road. Many states require similar soil studies for lower class roads.

It is important in selecting proposed highway sites to study the types and extent of soils to be traversed by the road. Differences in the characteristics of the soils as sub-bases, the difficulty of using some types of soil for fills, and other factors may result in excessive costs in construction. Sometimes it is more economical to relocate a proposed highway over soil more favorable to construction.

Soil characteristics influence the design of highways. The requirements for sub-bases and the necessary thickness of pavements and other surfacing are influenced by the type of soil. Shrinkage of materials during excavation and compaction can be determined. Necessary tile, culvert, and other drainage methods depend on the drainage characteristics of the soil. Much of the necessary soils data can be obtained from the soil map or can be correlated with the soil types found on the map.

Many secondary roads are surfaced with local materials. A knowledge of soils and correlation of this information with engineering laboratory tests of local soils facilitate the selection of such materials. Economy in both construction and maintenance results.

Sources of desirable road construction materials can be located through study of the soil map. Nearby locations of sand, gravel, binder soils, and other deposits can be determined, thereby reducing the costs of hauling.

Highway maintenance and beautification can also be facilitated on the basis of adequate soil information. Types and productivity of soils in cuts and fills will govern the species of planting for beautification and erosion control. Necessary fertilizers can be selected to promote growth of such plantings.

Many engineers maintain that the proper and practical application of soils to highway engineering is perhaps one of the most essential factors in low-cost road programs. Consideration and study of the soil characteristics can reduce initial construction costs by selection of suitable sites and preparation of adequate designs. Final costs are reduced through minimum maintenance after the road is completed.

Airports

Though soil is not the only factor influencing economical airport design, it is one of importance. Often it is the critical factor, as the major costs in airport construction are excavating, grading, paving, or turfing, and installing drainage systems. All of these are closely related to soil properties.

Soils greatly influence the selection of sites and design of airports. The load-supporting characteristics, the drainage qualities, and the stability of the soils must be considered. Proper soil information will permit the most economical design for sub-bases, thickness of runways, taxiways, and turnabouts. Drainage systems can be designed to meet the requirements most economically.

Construction work is facilitated through the location of readily accessible gravel deposits or other types of soil needed for fills, sub-bases, and taxiways.

Pipe Lines and Cables

In laying cross-country pipe lines and cables, a knowledge of the soil is helpful. Some soils are highly corrosive to pipe. A knowledge of these soils and of their location and extent along a pipeline site permits the engineer to cover the pipe with materials to prevent this corrosive action. Telephone cables are usually laid in shallow trenches. Soil erosion frequently exposes the cable, resulting in breaks or other damage to the line. If the engineer knows which soils are most susceptible to erosion and where they occur, he can take the necessary precautions to protect the cable.

Irrigation and Drainage

To the irrigation engineer, soil information is of vital importance. It is needed first to select land for irrigation, then in determining the method of irrigation and solving problems of drainage and salt removal. When transporting irrigation water over long distances, the loss through porous soils can seriously affect the quantity delivered. Routing the canals over suitable soils, or lining the canals with non-porous materials, will reduce this loss.

The engineer dealing with drainage problems, must also consider soils and their characteristics. Not all wet lands can be economically drained. In practical application, the desirability of drainage is determined by the cost compared to the increased crop production or value of the land resulting from drainage. A knowledge of the soils will help to determine whether or not it is practical to drain and will largely govern the type, depth, and spacing of drainage ditches.

Military

The military engineers have found soil maps to be useful in the transportation and emplacement of heavy military equipment. They give invaluable information in predicting trafficability conditions for both wheeled and tracked vehicles.

Amphibious warfare as executed in the recent world conflict emphasized the importance of soils as related to beachhead landings and operations of heavy mechanical equipment.

Miscellaneous

Soil information plays an important part in many other engineering activities. In the maintenance of railroads, it is useful in the treatment of cuts and fills to prevent landslides and erosion. A knowledge of soil characteristics is of material value in selecting the type of vegetative cover for cuts or fills, or in determining the slope of cuts to prevent slides.

It concerns the engineer dealing with dams and other large structures. Those working in water control must determine the kinds of soil in the watershed. These, to a great extent, are a factor in the design of dams, sedimentation basins, and similar structures.

The agricultural engineer must take into consideration the soil and its characteristics in designing and constructing small dams, flumes, terrace outlets, terraces, and other mechanical means for erosion control and water disposal.

SPECIAL MAPS

For the detailed design of highways, airports, and similar construction, a highly detailed soil map is often necessary. The system of classification can be essentially like that of the ordinary published detailed soil maps. The boundaries are surveyed more accurately in respect to the engineering stations, outlining even very small areas; some soil types may be subdivided to indicate greater detail of drainage and other factors as needed; and a more detailed recognition may be given to the character of the deep, underlying strata.

In the 50 years of soil surveys, 1,578 counties and areas covering approximately 1,571,000 square miles have been mapped and published in the continental United States. Many of these soil maps are of a reconnaissance type, or for other reasons are classified as inadequate for modern agricultural planning and operations.

Copies of the Soil Maps and Reports can be obtained from the U. S. Department of Agriculture or the Government Printing Office in Washington, D. C. For reference purposes they can be found in the principal libraries throughout the United States.

I trust this discussion of the soil map and some of its uses in engineering will be of benefit to those of you who encounter soil problems in your work.

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Florida Surveying and Mapping Conference

THE SECOND Surveying and Mapping Conference, sponsored by the Civil Engineering Department as a function of the Engineering and Industrial Experiment Station, University of Florida, was held in Gainesville on October 6 and 7. The attendance this year numbered 220 civil engineers, surveyors, engineering students, and real estate representatives.

The objective of the conference was to bring together those interested in surveying and mapping for a discussion of the problems and techniques of mutual interest to mapping organizations, land surveyors, and real estate interests.

The program consisted of four principal topics—New Developments and Techniques in Surveying and Mapping, Federal Mapping Agencies and Their Programs, The Florida State Coordinate System, and The Problems of the Land Surveyor. Participating in the program were consulting engineers and land surveyors and representatives from the U.S. Geological Survey, the Coast and Geodetic Survey, Engineer Research and Development Laboratories, Fort Belvoir, Va., Aero Service Corporation, Offshore Navigation Company, the University of Florida, Florida State Road Department, Florida State Improvement Commission, Florida State Geological Survey, and the Humble Oil Company.

One of the highlights of the program was a very forceful paper delivered by E. R. Lampp, Consulting Engineer, Ocala, Florida, calling on the land surveyors of Florida to improve the standards of their work and to cooperate with each other for the betterment of the profession. His ideas and suggestions were endorsed in a resolution adopted by the conference.

The conference also went on record as favoring continued efforts to establish a central state organization for the collection and dissemination of maps and mapping information as recommended by the 1948 conference.

—THOMAS L. BRANSFORD

Trig-Traverse

A Method of Establishing Third-Order Horizontal and Vertical Control by the Use of the Subtense Principle

By JOSEPH G. KELLEY

CHIEF FIELD ENGINEER, AERO SERVICE CORPORATION, PHILADELPHIA, PA.

IT HAS LONG been apparent that there is need for a horizontal control method which is neither traverse nor triangulation, but which fulfills a requirement between these two.

Triangulation, to be extended, requires the intervisibility of several points from any one. In terrain with few open hilltops this usually demands extensive reconnaissance and the building of observing towers. If only third-order closures are required, the cost of extending control by triangulation often becomes prohibitive.

Transit and tape traverse has been the generally accepted solution to the third-order horizontal control problem over terrain unsuited for easy triangulation. However, the location of traverse is limited by difficulties of chaining. Consequently, traverse follows roads and highways wherever possible. But the meanderings of the roads, as well as traffic interference, reduces the amount of traverse which can be run in a working day.

The use of the theodolite and subtense bar offers a partial solution to the problem of control costs. The subtense bar is a horizontal bar supporting two targets equidistant from its center, the distance being rigidly controlled by an invar wire. In determining the distance between traverse stations, the subtense bar is centered on one station and the bar lined up perpendicular to the traverse course through a sighting device. The angular distance between the targets is observed by theodolite pointings from the other end of the course; the length of the course is computed by the known distance of the subtense base and the angular measurement subtended by it.

Proponents of this method claim that distances of about 500 feet can be determined within third-order limits. However, this method—like transit and tape traverse—is also restricted by the meanderings of roads, offering an occasional bridging of a stream or gully which might not be possible by taping.

HORIZONTAL CONTROL BY THE TRIG-TRAVERSE METHOD

The existence of many open hilltops in the United States and over most of the world suggests that by expanding the subtense principle more rapid survey progress can be made over terrain difficult for both triangulation and traverse. The method developed by Aero Service Corporation, which fills this need, has been named Trig-Traverse. It adapts the subtense principle to afford greater flexibility and more rapid field progress.

In the trig-traverse method, the base need not be set perpendicular to the course, but may be established at an angle more convenient for measurement. Instead of the short subtense bar this new method employs a standardized steel

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tape, expanding the base measurement up to 500 feet. This makes possible the spacing of stations at intervals of as much as 2, 3, or 5 miles. Under the trig-traverse method the cotangent of the subtended angle is used to compute the distance of the subtended course, rather than twice the cotangent of half of the subtended angle, the computation made for the subtense method.

Figure 1 is a graphic comparison of the two methods. The course length to

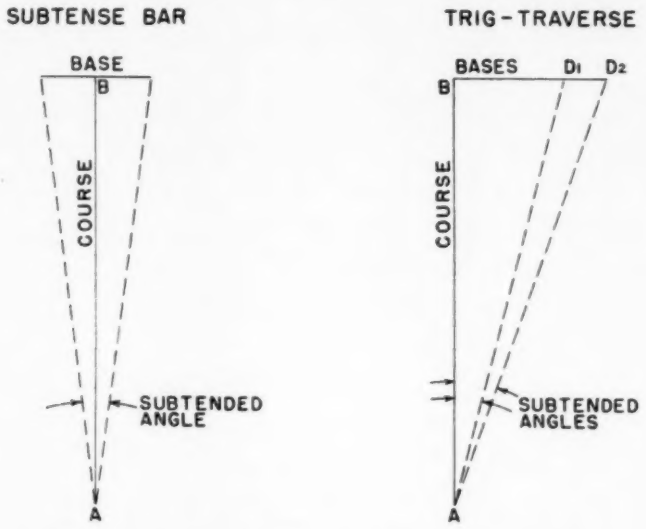

FIGURE 1.—Comparison of subtense bar and trig-traverse methods.

be determined in each case is indicated by the line *AB*. Relative lengths are not shown as these will depend upon the subtended angle in the case of the subtense bar and the length of the base and the subtended angle in case of the trig-traverse method. For measurements of third-order accuracy with the subtense bar, the course length *AB* cannot be greater than 500 feet. But with the trig-traverse method, using a 500-foot base, the course length can be increased up to 28,644 feet, still fulfilling third-order requirements.

It is evident that the trig-traverse base cannot be measured as accurately as the subtense base. Therefore, two bases are used in the trig-traverse method. Field experience indicates that the value of the two-base system offsets to a great extent the slight inaccuracy of the base measurement. The two bases are shown in figure 1 as *BD1* and *BD2*.

In developing this new method it was necessary to work out some practical answers on base targets, base and subtense angle measurements, and traverse angulation, which are pertinent to this discussion. In the trig-traverse method, for example, it was found that the base targets must be designed for accurate reading and easy identification for both short and long courses. Differentiation of the station and base targets must be readily apparent.

The main station rod has two targets; the base rods, *D1* and *D2*, have a

single target. All rods are 4 inches wide with a one-half inch red center stripe. Centered within the red stripe is a one-sixteenth inch white stripe. This white stripe may be used for pointings where the course is very short, but its principal purpose is to establish the center of the rod for measurement of the base.

For base measurements, tapes are used which have been compared with the National Standard of lengths. A constant tension is applied to the tape in making all measurements to simplify corrections for tension and sag. Extreme care must be exercised in making the base measurement, for any error here is proportional to the relative lengths of the course and the base. Where length determinations are to be 1 part in 10,000, the ratio of the course length to the base length is 20 to 1, so an error of 0.01 foot in the determination of the base would result in an error of 0.20 foot in the course. Base distances should be accurate, therefore, to less than 0.01 foot, preferably to 0.005 foot or closer.

With the trig-traverse two-base system, the effect of an error in base determination is reduced to approximately 70 percent of the effect of a single base error. Furthermore, the two-base system provides a check for any gross errors in the base measurement, since each base is measured separately and the distance *D1* to *D2* is measured for a check.

For measurement of the distance subtense angles, a precise theodolite reading to 1″ or less is required. With a second-order instrument, relatively longer bases are required. Moreover, with a first-order theodolite, the base-length ratios described later in this paper can be used as a guide for closure errors. It should be noted that excellent perception and skillful manipulation of the instrument are required of the observer.

Reasonable control over the accuracy of the distance measurements can be exercised by limiting the ratio of the length of the base to the length of the course. Experience indicates that good theodolite observers can be relied upon to measure small angles within approximately 1″ of arc. When the base ratio is 1 to 20, the angle subtended by the base is approximately 2°51′45″ or 10,305″. Therefore, an error of angular measurement of 1″ would result in an error of 1 part in 10,305 in length determination.

Multiple readings materially increase the degree of accuracy, but both field and computing costs mount with the increase in pointings. A skilled and experienced observer is mindful of the balance to be maintained between necessary pointings and the desired accuracy, under various conditions. Under good lighting conditions and with a proper base-course ratio, one set of pointings direct and one inverted are all that is required.

Traverse angulation under the trig-traverse system is determined with the theodolite. Angulation errors of the best observers will be 1″ or less per station, with one pair of readings. However, assuming that the angulation error is 2″ per station, the error from this source—considered generally as compensating—would be only a negligible amount.

Only third-order accuracy—1 part in 5,000—is claimed for the trig-traverse method. However, most closures are of a higher order. Third-order closures have indicated an error in the work. The bulk of our closures fall around 1 part in 20,000 with a large percentage indicating closures of a higher order. It is evident that the traverse is materially helped by the accurate azimuth determinations with the theodolite, which accounts to some extent for the excellent closures usually obtained.

Computations under this method are somewhat burdensome when compared to transit- and tape-traverse computations on a station-to-station basis. However, the trig-traverse method reduces the number of stations required so that the total number of computations is less than that required by the older method. In a recent traverse, for example, 40 stations averaging 1 mile apart were required to complete the traverse between two Coast and Geodetic Survey triangulation stations. It is estimated that 60 miles of transit and tape traverse would have been required to cover this, averaging five stations per mile, or a total of 300 stations. Accordingly, a greater computation effort per station is justified in the trig-traverse method.

Two main steps are necessary to compute the length of the course. First step is the reduction of the measured length of the base line to a true horizontal length. Corrections which must be applied are tension, temperature, slope, and the slope modification for the tension.

With the corrected base measurement the length of the course is computed as the second main step. The equivalent length of the base, perpendicular to the course, is computed from the known angle between the base and the course and the measured length of the base. This component of the base, multiplied by the cotangent of the subtended angle, determines the greater part of the length of the course. To this is added or subtracted the component of the base which falls within the course or the course extended.

Two independent lengths are computed for each course, one from each base. The final length of the course is the mean of the two computed lengths. A comparison of the two lengths obtained is an indication of the reliability of the length determination.

Some examples of the distances obtained on a recent survey are shown in table 1.

TABLE 1.—*Distances Obtained on Recent Survey*

Course	*Distance from Base B-D1 (Feet)*	*Distance from Base B-D2 (Feet)*	*Mean (Feet)*	*Ratio of difference of mean and one length determination to total length*
37–38	4,093.58	4,093.63	4,093.61	1: 204,682
38–39	6,162.42	6,162.29	6,162.35	1: 101,038
39–40	990.93	990.96	990.95	1: 99,095
40–41	2,316.93	2,317.17	2,317.05	1: 19,309
41–42	4,312.11	4,312.61	4,312.36	1: 17,250

Although these length determinations do not represent a comparison to an absolute length, they do indicate a high order of consistency on the part of the observer. These length determinations have been extracted from a 17-mile traverse which closed 1 part in 42,005.

Examination of the Accuracy to be Expected

The error of closure of the traverse due to angulation for azimuth determination is negligible. Since it is such a small quantity, it will be neglected as a consideration for closure error. The closure error will be considered therefore as completely dependent upon the length determinations.

By limiting this discussion to the most probable maximum error of a single length determination and considering this error as the amount to be expected in each length determination, the probable error of closure to be expected can be determined very conservatively. Repetitions of the subtended angles can therefore be considered as a safety factor to more than assure a closure indicated by the result of a single observation. For the purpose of this discussion, the assumed errors are 1″ in angulation and 0.005 foot in base measurement.

ANGULATION ERROR ± 1 SECOND
SUBTENDED ANGLE 7200 SECONDS

	SUBTENSE BAR (2 METER BASE)	TRIG – TRAVERSE SINGLE BASE 100 FEET	TRIG – TRAVERSE TWO BASES AV. 100 FEET
PROBABLE ERROR OF BASE	0.000	0.005	0.005
PROBABLE ERROR OF ANGULAR MEASUREMENT	1 SECOND	1 SECOND	1 SECOND
PROBABLE ERROR OF LENGTH DETERMINATION DUE TO BASE ERROR	0.000	0.143	0.143
PROBABLE ERROR OF LENGTH DETERMINATION DUE TO ERROR IN ANGULAR MEASUREMENT	0.053	0.402	0.402
LENGTH	375.92	2863.62	2863.62
TOTAL PROBABLE ERROR	0.053	0.427	0.302
RATIO OF ERROR TO LENGTH	1:7092	1:6705	1:9482

FIGURE 2.—Comparison of accuracy of subtense bar and trig-traverse methods, using a single measurement.

In figure 3 the probable error of a single observation is indicated. From this chart the most probable maximum error for a given length can be determined for a given subtended angle.

Figure 4 indicates the ratio of the error of closure to the length. From this chart the base length and angular relationships which will give the results desired can be determined. The results thus indicated can be materially improved by repetitions of the subtended angles. Safe closure assumptions can be made with these charts. Field results indicate much better closure. Table 2 shows typical results extracted from a recent trig-traverse in Maryland.

TABLE 2.—*Typical Horizontal Closures*

Coast and Geodetic Survey Triangulation Stations	*Length of Traverse (Feet)*	*Closure*
Marpen to Marpen	64,037	1:27,130
Marpen to Penmar	87,791	1:42,005
Penmar to Beacon No. 10	44,037	1:15,291

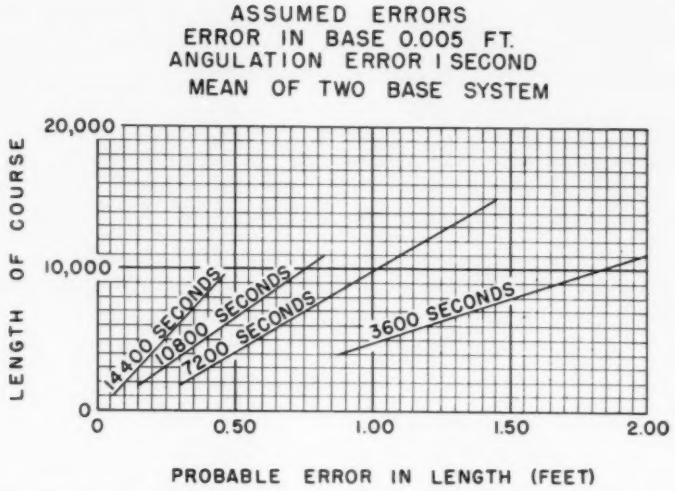

FIGURE 3.—Probable error in length (feet) using trig-traverse method.

VERTICAL CONTROL BY THE TRIG-TRAVERSE METHOD

It is apparent that since the trig-traverse station must be occupied for the horizontal control, the vertical angle to the next station can be very easily determined. If this can be accurately measured, bench levels of third-order accuracy between the stations can be established.

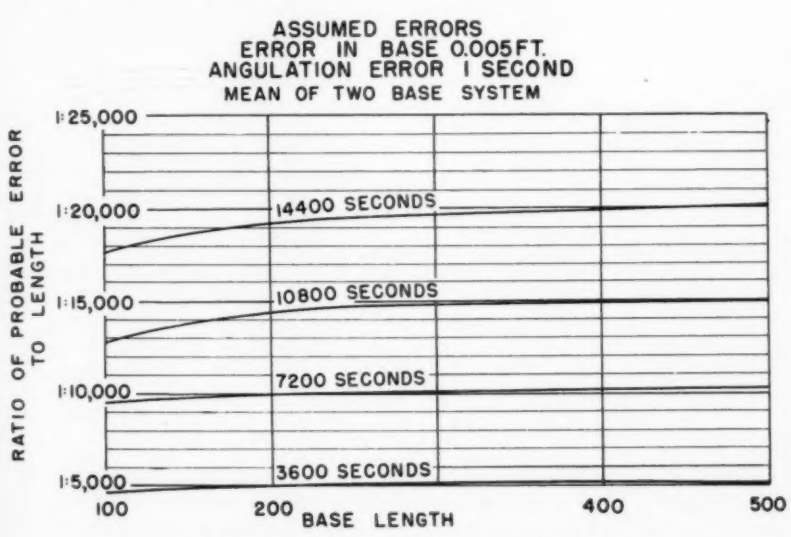

FIGURE 4.—Ratio of probable error to length.

With precise theodolites and a few precautions, very dependable bench level elevations can be determined. Determination of vertical angles can be held within approximately 2″. An error of 1″ may be attributed to error in centering the collimation level. Multiple readings are necessary for accurate determination of vertical directions.

Experience indicates that one vertical target is not sufficient to reliably carry bench levels by vertical angles. The use of two vertical targets permits a check on the accuracy of each determination of difference in elevation. Moreover, it permits use of different parts of the micrometer, thereby compensating to some extent for any irregularities in the micrometer divisions.

Reciprocal observations from each station of the course are necessary to minimize refraction errors. Vertical refractions vary with atmospheric conditions and the time of day. To reduce this effect as much as possible, reciprocal observations should be made within the shortest time element possible on the same day. Observations should be avoided within the hour nearest sunrise or sunset.

Advantages of the Two-Target Method

Where two targets are used to determine vertical differences, a comparison of two direct and two reciprocal elevation differences will indicate the relative accuracy obtained. The distance between targets is known and serves as a check on elevation differences obtained. By using the mean of the results obtained, the accuracy of elevation measurements is greatly improved over those obtained with a single target.

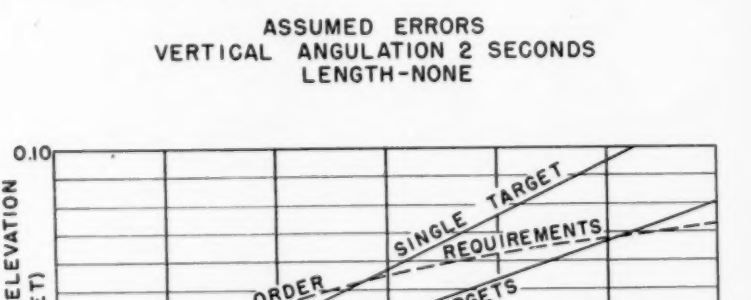

FIGURE 5.—Probable vertical error of a single pointing (neglecting refraction).

Figure 5 shows the results which may be expected from a single pointing with a single target and a single pointing on each of two targets, as compared to results expected from third-order spirit levels. In actual practice with multiple readings the results of leveling by vertical angles should be better than

the results indicated here. With precision theodolites, the vertical angles are determined by one pointing with the telescope direct and one with the telescope inverted. With the two-target system, the elevation difference would therefore be the mean of four pointings in one direction. In field use two independent angular measurements direct and two inverted are made of each target, or a total of eight pointings in one direction. The same procedure is followed in the reciprocal pointings so that the elevation difference is obtained from a mean of 16 pointings.

In computing the elevation differences, an arbitrary refraction constant is applied to the vertical angle. Although this step can be omitted, it serves as a check on the reciprocal observations. Some variations will be noted in refraction, but as long as the reciprocal observations are made within a short period of time, the refraction will not change an appreciable amount on the reciprocal observations. Thus, the mean elevation differences will be very close although the refraction correction applied may not bring the elevation differences within the range of third-order limits. Consistent accuracy in closing errors is the final criterion of vertical closures. With the best observers, these average 0.01 foot per mile.

The elevation closures obtained in a recent survey in Maryland are shown in table 3.

TABLE 3.—*Elevation Vertical Closures*

Bench Mark	*Length (Miles)*	*Total closing error*	*Error per mile*
Marpen–Marpen	12.1	0.035	0.0029
Sta–38EOM	2.0	0.031	0.0155
38EOM–TBM1252.7	18.0	0.103	0.0057

SUMMARY

Although the single observation of a small subtended angle on a taped base has been used occasionally to measure distances, it is believed that the trig-traverse method described here is the first broad application of a complete procedure. Field experience has established the soundness of the principle; its successful application depends upon the following factors:

The choice of instrument is of primary importance. A first-order, portable theodolite is essential to obtain highest accuracy with the least effort. The instrument should afford a choice of magnifications, in order to take advantage of varying atmospheric conditions. The highest power consistent with sharp visibility should be used, for there is a definite relationship between accuracy and magnification. Obviously, the observer's perception and skill of manipulation must be on a par with the instrument's accuracy.

Next in importance is the standardized steel tape. A tape requiring minimum sag correction and offering the least cross-sectional resistance to wind is best. The tape should be under one tension for all lengths so that a single correction chart may be used. Accurate tension handles and thermometers for base corrections are a must. The targets and rods also must be constructed carefully and accurately to insure the accuracy of measurements.

In making the measurements, several base measurements should be taken to insure readings to at least 0.005 foot. The distance from *D1* to *D2* should be measured for a check on the base measurements.

In the angular measurements the plate reading should be changed for each measurement, so an independent check is always obtained. In making these measurements, conditions causing horizontal refractions should be avoided—such conditions, for example, as the line of sight passing too near to trees and buildings. Avoid errors in the vertical angular measurement arising from too long time spacings of the reciprocal observations or from local disturbances of the vertical refraction.

Shading of the vertical level bubble is essential. Consistently good horizontal results are obtainable without shading the instrument and tripod, but undoubtedly some improvement would result from such shading.

Finally, a computing form which is self checking, making computation errors readily apparent, should be employed.

The trig-traverse method has been field tested for 3 years by several observers under varying conditions of climate and terrain. Over 800 miles of control have been established by this method. In all these tests only one gross field error has occurred, although small errors were detected which have been corrected in developing the procedures outlined here. It is believed this new method will deliver consistently dependable results, at a marked saving in time and cost, in terrain where it is applicable.

Discussion

By LANSING G. SIMMONS

PHYSICAL SCIENCE ADMINISTRATOR, U. S. COAST AND GEODETIC SURVEY

AS Mr. Kelley has explained, there is nothing new about the idea of traverse measurements wherein the distances are determined by subtense bases and measurement of small angles. Much has been written on the subject and many claims of high accuracy have been made, particularly in some of the literature distributed by foreign instrument makers. However, when high accuracy has been obtained it was generally at the sacrifice of speed and economy, as the lengths of the subtense bars are usually of the order of 1 or 2 meters, immediately limiting the length of the line to be measured.

Mr. Kelley is to be highly commended in putting the method on a practical basis and extending it to include the measurement of elevations. It is this type of imagination and practical application that is all too rare in the surveying field.

One must be careful in balancing costs against results. If certain methods require expensive equipment the savings effected must be substantial. If the expensive equipment is needed anyway for other operations, the savings may not have to be as great.

The method adopted by Aero Service employs a 200-foot tape for the measurement of the subtense bases and a Wild T-3 theodolite for the measurement of subtense angles. Experience has shown that both third-order traverse and third-order leveling are easily attained and that in many instances second-order closures have resulted.

At first thought it would seem that such accuracy is impossible when lines up to a mile or even more are included in the work. Let us examine the problem and see just why this is possible.

First of all, there is the need of assuring ourselves that the subtense base has the necessary proportional accuracy. If third-order accuracy is to be met, we should think of an accuracy of about 1 part in 10,000 at least for the base. This means that no uncertainty greater than 0.01 foot per 100 feet should exist. The tape should be standardized by the National Bureau of Standards or a comparison made with another tape so standardized. These standardizations should be made under the same tension employed in the field in order to eliminate the uncertainty in the stretch of the tape. Also, the tape to be used should be uniformly graduated because in practice not just the over-all length of the tape is used, but any number of divisions on the tape may enter into the measurement.

Assuming a tape 100 feet long, weighing 0.02 pound per foot, under a tension of 20 pounds, the rate of change of the length per pound change in tension is 0.004 foot. The temperature correction is about 1 part in 10,000 (steel) for every 15° F. change in temperature. So it appears that, with the proper precautions, even a short base may be measured rapidly and with sufficient accuracy. A single catenary is of course the easiest and most natural way of doing this.

The real critical part in the subtense method is the measurement of small angles with the highest of precision, and here is where the Wild T-3 comes into prominence. Assuming a subtense angle of 2° 7,200″) an error of 1″ in the angle measurement will produce an error of 1 part in 7,200 in the computed distance. This means that the subtense angle must be known to within 0.7″ under these circumstances if 1 part in 10,000 is to be maintained.

Large angles, of from say 10° to 90°, cannot possibly be measured to this accuracy at one setting of the circle. There is a periodic error in the graduated circle which is likely to exceed this amount over a large portion of the circle. This can be eliminated only by a uniform distribution of the readings over the entire circle, involving several measurements of the angle. Moreover, the effects of lateral refraction alone would quite likely make such precision very difficult to attain in all cases.

However, in the measurement of small angles these statements do not hold. In an angle of 2° the lines of sight to the two ends of the subtense base pass over almost identical paths, and the lateral refraction in each case should be very nearly the same amount and in the same direction and would not enter into the measurement of the angle in any significant amount. Also, the periodic error of the graduations of the circle would have little or no effect over a range of even 5°, let alone 1° or 2°.

Now, the micrometer enters prominently into the measurement of small angles and if it had an error in "run"—that is to say, it did not properly measure the interval between two successive graduations—any accuracy attained otherwise would be nullified. A test can be made on this and should such an error exist, it could be eliminated by changing the setting of the circle just enough to distribute the readings uniformly over the micrometer scale. However, it has been my experience that the error of run in the micrometer of the Wild T-3 is usually negligible. Another source of error would be the lack of uniformity of the graduations on the micrometer scale. This also can be tested by measuring small angles with different parts of the micrometer scale and com-

paring the results. Again, we have found that in the case of the Wild T-3, the uniformity of the micrometer graduations is of a high order.

A good experienced observer can be expected to make a single pointing within about 0.75″ of arc, provided observing conditions are good, the targets well defined, and a high power telescope is used. If two or three pointings are made on each target of the subtense base, there should be no trouble on this score. So it would seem that it is quite possible subtense angles can be measured within an error of 0.5″ of arc under favorable conditions and with an experienced observer, and a theodolite of the Wild T-3 type.

Taking up the matter of trig leveling, let us assume as a basis of discussion that we are going to observe over a line 1 mile in length and wish to attain an accuracy in the difference of elevation of 0.05 foot, the maximum allowable in third-order leveling. Pointing the telescope within this limit presents no problem as it represents a range of $\pm 2''$ of arc. All vertical angles must be referred to a spirit level of some sort and in the case of the Wild T-3 this level is attached to the vertical circle and is centered after each pointing. The bubble has a sensitivity of 12″ per 2-millimeter run. Because it is centered by the coincidence method wherein the two ends of the bubble, through a system of prisms, appear side by side and move in opposite directions, the centering may be made within 0.2 millimeter without any difficulty. This is equivalent to an angle of 0.6″. The important thing is that the bubble axis does not change in relation to the graduations of the circle between the direct and reverse pointings of the telescope. To insure this the level should be shaded, preferably by a large umbrella, from the direct rays of the sun. So we find that the accuracy stated is within the range of possibility, insofar as the pointing and the sensitivity of the level bubble are concerned. It is assumed that the conditions are favorable for clear visibility of the target. It is also assumed that for every measurement of vertical angle at least one pointing direct and one pointing reverse is made, although two each should be made to guard against bad pointings or erroneous readings. Incidentally, the readings of both the horizontal and vertical circles can be very easily made to within 2 or 3 tenths of a second.

The chief source of trouble in vertical angle measurements is the effect of vertical refraction and unless reciprocal observations are made—that is, measurements over both directions of the line—third-order accuracy could not possibly be attained when the line approaches 1 mile in length. Even though reciprocal observations are made, there is an interval of time between them during which refractive conditions may change. In these cases the effects of refraction cannot be eliminated. Moreover, even though simultaneous reciprocal observations are taken, the effect of vertical refraction is not entirely eliminated, as the lines of sight in the two directions do not necessarily follow the same paths. However, the experience of the Aero Service Corporation has indicated third-order accuracy is consistently attained and the second-order accuracy on occasions is possible.

The computation of the field observations is another thing and therein lies one of the greatest chances of errors. The methods employed by Aero Service are such that field blunders are practically impossible and it might be well to consider such guard against office computations.

At any rate the method is very intriguing and should be recognized as perfectly adequate when properly employed in accomplishing work under third-order specifications.

The Legal Status of the Surveyor in Canada

By C. C. LINDSAY
QUEBEC LAND SURVEYOR AND CIVIL ENGINEER, MONTREAL, CANADA

I AM DEEPLY HONORED by being asked to present a paper before the American Congress on Surveying and Mapping, and to find myself in such distinguished company. The subject upon which I am about to discourse is a very large one; in fact, it is as large as the large expanse of territory which is covered by our great Dominion of Canada. I will endeavor to give it as adequate coverage as possible in the time at my disposal.

Surveying in Canada comes under two general categories. Firstly, there is the survey of the lands which are the property of the Crown and which are administered by the Government of the Dominion of Canada; and secondly, there is the survey of the lands which are included within the limits of the Provinces and which are under control of the Provincial governments and/or private individuals or corporations.

MAPPING OF NORTH TERRITORIES

The first includes the mapping of the vast territories of the North, in which process use is made of every modern device of aerial photography. Our surveyors in the Department of Mines and Resources were amongst the pioneers on this continent in the use of aerial photography for mapping purposes and have kept well abreast of the times in this important subject. This category also includes all geodetic surveys, and the hydrographic surveys of our rivers and harbors.

The Northwest Territories at one time included all that part of Western Canada which lay north of the United States between the head of the Great Lakes and the Province of British Columbia. When this huge tract of land was to be opened up for settlement, our then Surveyor General for the Dominion, Dr. Deville, devised a new system of survey which has proved most successful. To do the actual work of laying out this new system, which required the extremely accurate location of base lines, meridians, and township lines, and the subdivision of these townships into ranges and sections for colonization, skilled surveyors were required.

It was recognized that the job was a gigantic one and, consequently, one which would last for many years. Therefore, a Manual of Instructions was prepared; surveyors who wished to be employed upon this work were required to submit to an examination upon their professional and mathematical qualifications and upon the contents of the Manual; and in this manner the Dominion Land Surveyors Association was born. In proceeding in this way, the Association was following in the footsteps of the Provinces, which had a similar method in existence for the qualification of their surveyors. I will deal with this method at greater length a little later on.

Today much of the Northwest Territories has been absorbed into the Western Provinces, whose northern boundaries now extend to the 60th parallel, while Ontario extends to Hudson Bay, and Quebec goes as far north as Hudson Strait.

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While the southerly boundaries of the Territories were thus pushed very far north, their northern boundaries have been extended also northward through new discoveries and exploration and the use of the modern aeroplane for communication. Therefore, while Dominion Land Surveyors engaged upon the subdivision of land for colonization purposes have found their work taken over by surveyors operating under the Provincial administrations, they still have a very great task to do in mapping, and in geodetic and hydrographic work, as well as on the survey of lands which still belong to the Dominion Government and in work connected with our great natural resources, such as the forest industry and mining. There is a close liaison between the work which is being done under Federal auspices and that being done under Provincial control, to the mutual advantage of both groups. The Dominion Land Surveyor's Association is now known as The Canadian Institute of Surveying; most members of the Provincial bodies are also members of it and in this manner benefit by contact with their colleagues in the Dominion Government service and in other Provinces.

CATEGORY OF THE SURVEYOR

The second category of survey covers that which is done by the surveyors in the various Provinces. It comprises the bulk of the surveying in the Dominion at the present time. Under this heading comes all surveying of Crown Lands under Provincial administration for settlement or for mapping purposes, and the establishment of meridian and base lines throughout the unsettled portions of our large provinces, as well as all surveys for private individuals, corporations, or industry.

Each Province has a Surveys Act under which its surveyors operate. These Acts govern the responsibility of the surveyor towards the public, the manner in which lands are to be laid out and/or measured, the qualifications which must be possessed by the surveyor and the subjects in which examinations will be held for admission to the study and to the practice of the profession, the period of indenture to be served by the students, the scale of fees which are to be charged, and the manner in which the surveyor's records are to be kept and the disposition of these records when he retires from practice or dies. They provide also for punishment by fine or imprisonment for the illegal practice of the profession or for the mutilation or destruction of boundary markers which have been legally planted, as well as disciplinary action to be taken against surveyors for unethical conduct. These Acts are part of the Law of the Land and have teeth in them.

In the Central and Western Provinces, there are associations or corporations which have been established by Provincial Statute for the administration of the Surveys Act, and the members of these associations and corporations have been duly commissioned and sworn to practice their profession in an ethical manner without fear or favor. In our case, The Corporation of Quebec Land Surveyors, of which I am a member, was incorporated by a statute passed in 1882. Although in virtue of my membership therein I am entitled to practice anywhere in the Province, I cannot practice in any other Province unless I am a member of the sister society in that Province.

All of these Acts have certain similarities, but, owing to different systems of surveying and property laws in the different Provinces, there is considerable variance between them in regard to the methods to be followed in the survey of land. It is obviously impossible to give you a dissertation upon all of the Provincial

Acts, so I will confine myself to that one with which I am most familiar, namely, the Province of Quebec.

Before doing so, I believe it to be of interest to give you a little of the historical background of the surveyor. Most people have a tendency to take us for granted and do not realize that ours is one of the most ancient and important professions in existence. There is no doubt that our profession dates back to the first time that a man acquired a piece of land by gift or by appropriation. In ancient Rome we find an official, the surveyor of his day, whose duty it was to lay out the respective properties of its citizens and of the state, and who was known under the name of "mensor." So high was his position and so great was his influence because of the boundaries which he planted that he ranked as one of the priests of the Roman pagan cult.

From these ancient times, we follow the career of the surveyor to France, which is the cradle of the French-Canadian people. Unquestionably, the profession of land surveying was also practiced in England since earliest times—else how did the people determine the limits of their holdings? But I will follow the fortunes of the surveyors in Old and New France because the records of their progress have been more easy of access.

Henry II of France in 1554 appointed an official of his Court to be "Arpenteur Royal," which title can be translated as "Surveyor to the King." The word "arpenteur" is derived from the arpent, which is a measure of both length and of area in the French Tables of Lineal and of Square Measure. This official delegated powers to subalterns, who were commissioned for each judicial district; these latter had to be of good moral conduct, and have a good practical knowledge of arithmetic, geography, such mensuration as was known at that time, and of the customs and laws of the district in which they served.

In 1668 Louis XIV suppressed the title of "Arpenteur-Royal" and reserved to himself the right to appoint surveyors, to whom he awarded the diplomas of their office after being assured by responsible authorities of their fitness for their position. He instituted the system of making them take an oath of office, and enjoined upon them the necessity of proceeding strictly according to the law and to their consciences, under penalty of losing their commissions. These surveyors, known as "Arpenteurs jures" or "Sworn Surveyors," were commissioned for each town, city, or district, and their particular duty was the measurement of land and the settlement of disputes between proprietors. This edict of Louis XIV also stated that they could fill the offices of notary royal. These surveyors formed a privileged body; and it became mandatory that, as and when a dispute arose, one of their number had to be chosen by the contestants or by the Court of Justice to establish the position of the disputed areas and to fix the final boundary line. This is the method and the procedure followed to this day in our Province, as I will explain to you a little later on.

This date of 1668 brings us to practically modern times in French Canada, whose motto is "Je me souviens" or "I remember." Jacques Cartier sailed up the Gulf of St. Lawrence in 1534, and Samuel de Champlain founded the city of Quebec in 1608. Champlain was a land surveyor by profession, and he made maps of all the routes which he explored in New France. He also laid out, personally, the limits of the property which the King granted to Louis Hébert, the first colonist in what is now the Upper Town of Quebec. Champlain's official title was Hydrographer to the King.

ORIGIN OF TITLE OF SURVEYOR GENERAL

Champlain was succeeded by Jean Bourdon, who practiced between the years 1634 and 1668. His official title was Surveyor General to the Colony, and he held his title directly from the King of France. He was also Attorney to the Habitants, and part of his duties was to settle property disputes between them and to act as attorney general to the Supreme Council. The name "habitant" was given to those colonists who lived permanently in the country, as compared with the officials and gentry who only stayed for the duration of their term of office, or who returned to France occasionally to visit their homes.

After Bourdon, there followed an unbroken succession of Surveyors General, whose names are known and whose records in many instances are still in existence. Under these Surveyors General were a number of assistant surveyors, who were also duly commissioned and sworn, and who served the needs of the Government and of the individual. One of the most important in his way was Louis Joliet, who with Father Marquette discovered the Mississippi River.

The first Surveyor General under the British regime was Major Samuel Holland, one of Wolfe's officers and protégés, a man of high repute who rendered excellent service. His district covered much of what is now United States territory, because this was a number of years before the War of Independence. As previously mentioned, this title has been carried down through the intervening years so that at the present day each Province has its own Surveyor General, and so has the Dominion of Canada.

LEGAL ASPECTS OF SURVEYING WORK

And now to discuss the legal aspects of the surveyor's work. In our Province of Quebec, our criminal law is the Law of England, and our civil law is the Law of France. When Britain conquered Canada in 1759, one of the terms of the surrender was that the French-Canadian people would be granted the right to keep their own civil laws, their religion, and their language. This agreement has been scrupulously respected. Therefore, our Civil Code is based upon the Code of Old France.

Possibly the best way of explaining the legal status of the surveyor in our Province is to consider the most important of his functions, the establishment of a boundary.

Under our laws it is the inalienable right of every proprietor to compel his neighbor to join him in the establishment of a boundary line between their respective properties. This may be done amicably or through the courts, and the surveyor is the public officer charged with the execution of this work in virtue of his commission.

The most simple method of procedure is for the two parties to get together, agree upon the necessity for establishing the line, and arrange to employ a surveyor who will mark it out for them, in the manner which I will hereinafter explain. The costs of this operation are borne in common.

Conditions as a rule do not work out as simply as this. All too often the neighbor is indifferent or hostile. He is either content with matters as they stand and shuns the additional expense, or else he is trespassing and does not want this encroachment halted. He does his utmost therefore to delay the proceedings if he can. However, the code is quite definite upon this point, and he cannot refuse to join the proprietor in the fixing of the boundary, which operation is known to

us as a "bornage." This term will be used in future reference for the sake of brevity.

If the neighbor is hostile or indifferent, the proprietor contacts a surveyor on his own account and instructs him to proceed with the establishment of the boundary. The surveyor then draws up a formal notice to the neighbor, advising him that he (the surveyor) will be at the disputed site at a specified time on a specified day for the purpose of establishing this line, and charging him (the neighbor) to be present at this rendezvous and to bring with him all deeds, plans, or other documents relating to the titles of his property. The neighbor is also advised that he may make use of the services of the surveyor who sends the notice, or have himself represented by a surveyor of his choice. This notice is sent by registered mail, or served upon the neighbor by a bailiff of the court.

The proprietor next door may not disregard this notice. If he does, he is automatically in default, and the costs of the proceedings may be adjudged against him subsequently, as this absence is considered to imply bad faith. He can of course be represented by an authorized deputy.

Once on the ground, the surveyors for both parties, assuming that the neighbor has selected a surveyor of his own, examine the deeds and other documents which have been produced, the official plans of the district, and all other information relative to this bornage, and make a survey of the areas in dispute.

Now, under our Civil Code, it is possible to obtain title to a piece of property by prescription under the following conditions: That the claimant has occupied the property in question continuously and uninterruptedly for a period of 30 years; and that this occupation has been peaceable, public and unequivocal, and as apparent proprietor. This is our version of the famous term "squatter's rights."

It will therefore be seen that another factor is injected into this bornage other than the titles to the properties; and, since the law presumes that he who is claiming prescription is in good faith, it is necessary for the other party to prove the contrary.

The surveyor is empowered by law to call any witnesses whom he may require, to swear them in and examine them under oath, and to use the evidence thus obtained in order to arrive at a decision upon the position of the boundary line. In this connection, it is to be noted that no one may interfere with or molest a surveyor in the execution of his duties; anyone so doing is subject to a fine and/or imprisonment, as well as any action for damages which the surveyor may take against him (or her) in the civil courts. Also, no one may prevent a surveyor from passing over a piece of property in the execution of his duty; the surveyor, however, is liable, upon proof of the damage, for whatever damage such passage may cause.

After all of the evidence has been assembled and studied, the line is laid out. Before any survey work is done, the surveyors are bound to swear in their chainmen under penalty of nullity of the proceedings; these latter make oath that they are not interested in either of the properties concerned nor connected with any of the parties, either by family or business relationships, and that they will do their work with accuracy and justice and render faithful account of the same to the surveyor or surveyors in charge.

The size, length, and vertical position of the boundary markers are specified by law. After these have been planted and the lines marked out between them,

a document called a "procès-verbal" of bornage is drawn up wherein the surveyors state that they are commissioned, sworn, and duly licensed to practice in the Province; that they have attended upon the ground for the specific purpose of fixing the boundary in question; and that they have proceeded to establish the boundary in the manner then described and have planted boundary markers at the points named in this procès-verbal and shown upon the accompanying plan. This plan is a graphical illustration of the text of this document describing the locations of the properties owned by the parties in relation to the line thus established and mentioning (1) that the line thus established is the permanent and irrevocable boundary line between the properties concerned, and (2) that it has been accepted by the parties concerned for themselves, their heirs, and assigns forever. These parties then sign this document, together with the surveyors in witness thereof. It is registered and becomes part of the title to the two properties.

It happens occasionally that the two surveyors do not agree upon the position of this boundary line, or that one or both of the proprietors will not accept the line thus established, even against the advice of his own surveyor. When this occurs and the differences are irreconcilable, the parties then have recourse to the courts, and the action taken is one known as the "Action in Boundary."

This Action in Boundary is also taken in cases where all efforts to effect an amicable choice of a surveyor or surveyors has failed, where the neighbor has neglected to attend in response to the summons, or where the two parties being distinctly antagonistic, one to the other, it is evident that efforts leading to a reconciliation would be useless and matters are taken directly to the courts.

When the case gets into court, the court names an "Expert Surveyor" for the purpose of making a plan of the premises showing the rival pretentions of the litigants. He is appointed in consultation with legal counsels for both parties. If there is objection to one man, two or more may be named, and each of these will prepare an independent report, although they may sit together to hear evidence. This surveyor (or surveyors) is then sworn in especially for this case, although he is already under an oath of office. He then establishes his court, hears the witnesses and studies the documents produced by the lawyers to both sides, listens to their arguments, and then goes out upon the ground and makes his survey in company with representatives from both parties. His chainmen are sworn in as mentioned previously, after which this expert surveyor prepares his report and plan for the court and makes a recommendation or a suggestion for the position of the boundary line. This report and its accompanying plan are sealed in an envelope upon the outside of which its identity is made clear, and the amount of the surveyor's fees and expenses incurred in the work is marked. A statement is also added that this envelope is not to be opened until the aforesaid fees and expenses have been deposited in court to reimburse him. After these have been paid, the report is examined by the judge, who may or may not agree with the recommendation, and who then gives judgment fixing the position of the line where the court decrees it shall go. The expert surveyor is then instructed to return upon the ground and mark out the position of this line accordingly, after which he makes report to the court. This report and the judgment are then registered against the properties concerned.

REGISTRY OF PLANS UNDER SURVEYS ACT

The surveyors in Canada have always enjoyed the support of their respective

Governments. For example whenever any new statute is passed laying down regulations to be followed by those industries which exploit the natural resources of the Province, such as the hydroelectric power companies, the forest industries, the mining companies, and the transportation companies, these statutes have always respected the powers granted previously to the surveyors and specifically mentioned that all plans and descriptions which have to be prepared to comply with the new regulations shall be prepared and signed by duly qualified land surveyors wherever these plans and descriptions cover matters relevant to the Surveys Act. No official plans may be registered in the cadastral or the registry offices unless they are prepared by a land surveyor in good standing.

In private practice we are fortunate in having similar recognition, to a great extent. Notaries, lawyers, and agents for trust and loan companies invariably demand a plan and accompanying Certificate of Location from the surveyor before proceeding with the business on hand affecting a property. This is similar to your practice here in the States.

Now, gentlemen, we surveyors in Canada have much in common with our colleagues in the United States. Your problems are our problems, and the struggle for existence and professional recognition is common to both. Therefore, it is with great satisfaction that we have noted the formation of the American Congress on Surveying and Mapping and have watched it grow. Glancing over its membership list, I was agreeably surprised to note the number of Canadians thereon, but there is room for many more. On behalf of the President of the Corporation of Quebec Land Surveyors, Mr. George Coté, who is a member of the Congress, and on behalf of the members of our Corporation, I wish you success in your good work of bringing together the surveyors of your great Nation, to their greater prominence and prosperity.

Caution With Regard to Buying Land

(Author and source unknown)

First see the land which thou intendest to buy
And that the seller's title clear doth lie;
And that no woman to it doth lay claim
By dowry, jointure, or some other name.
That it may cumber know, if bound or free
The tenure stands, and that from each feoffee
It be released; that the seller be so old
That he may lawfully sell, thou, lawful hold.
Have special care that it is not mortgaged lie,
Nor be entailed on Posterity;
What custom service it hath done of old
By those who formerly the same did hold.
If by a wedde woman put to sale,
Deal not with her unless she bring her male.
Thy bargain being made and all this done,
Have special care to make thy charter run
To thee, thine heirs, executors, assigns
For that beyond thy life securely binds.

The Variable Vara

By W. C. WATTLES
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THE vara is an old Spanish unit of measure which is still used in many of the Latin-American nations. Inasmuch as there is a slight difference in the length of the vara in many of the countries, the author feels the following table, showing its length in different localities, may be of interest to surveyors and map makers.

Table of Lengths for Vara

Political Divisions	*Inches*	*Authority and Remarks*
CURACAO	33.37	Funk & Wagnalls.
FLORIDA	33.372	U.S. War Department Educational Manual EM-908. "Castilian" vara: Mitchel vs U.S., 15 Peters 51, 57 (1841).
HONDURAS	33.03	Funk & Wagnalls.
	33.00	Webster.
MEXICO*	33.03773	Humboldt (1803). (1 vara = 839.16 mm.)
	32.95269	Agreement between Mexican Republic and Bond Holders 9/15/1837, from Commissioner, General Land Office Report (1854). (1 vara = 837 mm.)
	32.99312	Same as above.
	32.99206	Orbezogo (about 1844). (1 vara = 838 mm.) Also measured interval between marks on old standard rod from Arizpe, Sonora, Mexico, 838 mm.
	32.96568	Bustamente (1851). (1 vara = 837.33 mm.)
	32.96753	U.S. Coast Survey (1850). (1 vara = 837.377 mm.)
	32.9682	Standard from Mexico at close of Mexican War, in office of U.S. Coast Survey. U.S. vs Perot, 98 U.S. 428 (1878).
	33.00	U.S. vs Perot. Commissioner, General Land Office Report (1854). Webster.
	32.994	Webster. (1 sq. vara = 0.84 sq. yd.)
	32.99	Funk & Wagnalls.
	32.992	MERRIMAN, M.: American Civil Engineers' Pock Book.
	32.993	TRACY, J. C.: Plane Surveying. DAVIS & FOOTE: Surveying.
	33.38676	ALEXANDER, J. H.: Dictionary of Weights and Measures.
	32.808	Haggard Handbook for Translators of Spanish Historical Documents. (Geometrical ft. = 10.936 in. 1 vara = 3 pies geometricos.)
NEW MEXICO	33.00	Surveys of private claims; official recognition by court of private land claims.
PARAGUAY	33.00	Funk & Wagnalls.
	34.12	Webster.
PERU	32.91	Funk & Wagnalls.
	33.37	Webster.
PHILIPPINES	33.38	Webster.
PORTUGAL	43.28	Funk & Wagnalls.
	43.00	Webster.
SPAIN	33.36	Funk & Wagnalls.
	33.38	Webster.
	32.875	BRUHNS: Logarithmic Tables. TRAUTWINE. (1 Castilian ft. = 278.3332 mm.)
	32.913	MERRIMAN, M.: American Civil Engineers' Pocket Book.
TEXAS	33.40	Seth Ingram, Colonial Surveyor, in Document 8/18/1825. (Geometrical ft. = 11.13333 in. 3 geometric ft. = 1 vara [Spanish Bar].)
	39.60	Seth Ingram's chain used for measurement. (10 bars [varas] = 50 links [33 ft.].)
	33.3333	Established by Texas law (1919). (36 varas = 100 ft.)
VENEZUELA	33.38	Funk & Wagnalls.

* Conversions by relation to mm. based on 1 m. = 39.37 in. or 1 yd. = 36. in. = 3600/3937 m. 1 m. = 1,000 mm. (MERRIMAN, M.: American Civil Engineers' Pocket Book.)

Aerial Photographic Interpretation of Natural Vegetation in the Anchorage Area, Alaska

By KIRK H. STONE

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MAKING a geographic inventory in Alaska is a difficult task, but it can be done rapidly and accurately by aerial photographic interpretation. A representative example of the application and utility of the technique may be taken from the work of a land-classification party in the Anchorage area during the early summer of 1946.[1] The type of land classification to be carried out was one in which the natural vegetation was highly significant. It had previously been determined that certain vegetative types could be recognized when aerial photographs of the area were studied with a pocket stereoscope. Outlines were prepared of the distinguishing features of each of these types. These outlines, called "vegetative keys," were compared with field observations of physical features in selected areas, and the resulting correlations were used to classify less accessible parts of the area without detailed field work. The keys also proved useful for locating positions in the field, particularly in unsettled land where section lines had not been surveyed or where the survey had been made long before (more than 20 years). The stages in the working out of the vegetative keys and the details of each key are given below. Similar keys, or keys for other features of a landscape, could be made for any part of the world covered by aerial photography on the same or a larger scale.

The vegetative keys for the Anchorage area were constructed in nine stages. These stages are common to all aerial photographic interpretation, and they should be completed in the order given below.[2] They are:

1. *Documentary, Cartographic, and Photographic Research.* All available reports on, maps of, and ground photographs of, the Anchorage area were studied. Special efforts were made to obtain materials on vegetation, surface features, drainage, soils, and climate.

2. *Determination of Photographic Scale.* Photographs of the United States Air Forces were used. The scales of the vertical photographs were computed from data given on the margins of the first and last photographs of each flight (the representative fraction equals focal length of camera used divided by the plane's altitude at the time of photog-

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Appreciation is expressed to the Director of the Bureau of Land Management, U. S. Department of the Interior, for permission to include material from one of the writer's field reports; to the U. S. Air Forces, from whom the photographs were obtained; and to Professors V. C. Finch, A. C. Gerlach, and A. H. Robinson for helpful suggestions on the presentation of the material.

[1] In five weeks four field men and a clerical assistant classified about 60,800 acres, much of which has poor access, and compiled the classifications on a map, scale 1:31,680. The map was published by the Bureau of Land Management, Washington, D. C., in 1947.

[2] These stages should be compared with those described in G. F. Burks and R. C. Wilson: A Vegetation Inventory from Aerial Photographs, *Photogrammetric Engineering*, Vol. 5, 1939, pp. 30–42; and A. E. Wieslander and R. C. Wilson: Classifying Forest and Other Vegetation from Air Photographs, *ibid.*, Vol. 8, 1942, pp. 203–215.

raphy). These scales were checked by comparison of distances between given points on the photographs and on General Land Office township plats.

3. *Plotting and Indexing Photography.* The area covered by each vertical photograph and the number were plotted on a base map.

4. *Plotting Control on Photography.* The positions of section corners in the surveyed parts of the area were plotted on the photographs from the Land Office township plats.

5. *Preliminary Examination of Photography.* The photographs in each set (three sets were used) were overlapped in the manner in which they were taken, and the general patterns of vegetation, surface features, and drainage lines were studied with the naked eye and through a low-power reading glass. Boundaries were outlined with grease pencil.

6. *Computation of the Appearance Ratio.* Preliminary estimates were made of the amount of exaggeration of the slopes and heights of objects seen in stereovision. The estimates were made by measuring the apparent stereoscopic angle of a slope with a template[3] and comparing the result with the slope recorded in the cadastral-survey notes or a measurement made during a reconnaissance of the area.

7. *Preliminary Stereoscopic Study of Photography.* All vertical photographs, and where possible all oblique photographs, were studied stereoscopically before work in the field. Vegetated areas with similar tone and/or texture, outlined during the preliminary examination (Stage 5), were identified tentatively from descriptions in reports on the area (Stage 1), from reconnaissance work there, and from experience in areas near by. Also, parts of the area with unknown types of vegetation, with types not identified readily, or in distant positions on the oblique photographs were marked for detailed observation in the field.

8. *Field Work and Stereoscopic Study in the Field.* The tentative identifications of vegetation (Stage 7) were checked in the field. Parts of the area with unknown or questionable types of vegetation were observed in detail. Parts with different types of vegetation were carefully studied, and the variations in stereovision of tone, texture, stereoscopic appearance, pattern or shape of stand, and distribution were compared with appearances from the ground. In addition, pertinent observations were made on the relations of vegetative types to physical qualities of the land.

9. *Post-Field-Work Stereoscopic Study.* Upon completion of the detailed field work all the photographs were studied stereoscopically. The notes made during this last stage were combined with all other notes and observations to make the final keys.

THE ANCHORAGE AREA

Both during and after the construction of the vegetative keys their utility increased as the interpreter's knowledge of the area increased. Similarly, the utility of the keys depends in part on a preliminary summary of the physical conditions of the area.

The city of Anchorage stands at the northeast corner of Cook Inlet, where, according to Taylor's classification, there is part of the spruce–birch interior forest of the sparse type, a transitional coniferous forest between the hemlock–spruce coastal forest and the spruce–birch interior forest.[4] The forest is composed of a few simple associations or relatively pure stands of coniferous and broadleaf trees. Densities of the stand differ greatly, and the forest is broken irregularly by acreages of grass, swamp, bushes, and burns (Fig. 1). The principal trees are white spruce, white birch, black spruce, yellow birch, aspen, and cottonwood. Mature trees are 30–45 feet high, except black spruce, which is

[3] Details of computing the appearance ratio are to be described elsewhere.

[4] R. F. Taylor: Pocket Guide to Alaska Trees, *U. S. Dept. of Agric. Misc. Publ. No. 55*, 1929, pp. 5–7 and map.

10–20 feet, and all the trees have shallow roots. The larger bushes are willow, alder, and mountain ash; the smaller include buckbrush, Labrador tea, high-bush cranberry, currant, devil's-club, raspberry, and blueberry. The grass is called locally a "redtop." In general, the white spruce, white and yellow birch, and aspen grow on relatively warm, moist, sandy soils throughout the higher and better-drained parts of the area; the cottonwood and willow in cool, moist sites along stream beds; the black spruce, cranberry, and marsh grass in low, flat, poorly drained parts.

The topography is one of outwash plain and low morainic hills[5]; elevations generally are less than 250 feet above sea level but reach 500 feet in the southeast on the western foothills of the Chugach Mountains. In the center, south of

FIG. 1—Looking southwestward over the Anchorage area from about 15,000 feet above the eastern side of the area. Anchorage at center right.

Anchorage, is a large outwash plain, with maximum relief of about 25 feet to a mile, and on the east and west sides are low hills where the maximum relief is 100–150 feet to a mile. Along tributaries of Cook Inlet are steep cliffs 50–200 feet high, except at the mouths of streams.

Most of the outwash plain is a swamp, and from it fingers of swamp extend northeastward between the hills. In the hills to the west are several depressions, filled with swamp-edged lakes. The few streams are small and short; most of them follow winding courses westward or southwestward from the Chugach Mountains.

On the better-drained land the vegetation has taken root in shallow and

[5] S. R. Capps: The Turnagain-Knik Region, *in* Mineral Resources of Alaska . . . , 1915, by A. H. Brooks and others, *U. S. Geol. Survey Bull. 642*, 1916, pp. 147–194, *passim* and Pl. 8.

poorly developed soils, which in places are stony or gravelly. Soil depths range from less than an inch to an average maximum of 14–16 inches. In general, the soils are sandy loams under partly decomposed organic material three to five inches thick; they are underlain by gravel or layers of sand and gravel several feet deep. The vegetation is adapted to short, warm summers, long and moderately cold winters, and low and unevenly distributed precipitation. At Anchorage mean maximum temperatures range from 65.1° F. in July to 19.2° F. in January and mean minimum temperatures from 48.9° F. in July to 4.6° F. in January. The mean yearly precipitation is 14.5 inches; April is the driest month, with a mean of 0.41 inch, and August and September are the wettest, with means of 2.60 and 2.58 inches respectively.[6]

AERIAL PHOTOGRAPHY USED

The utility of the vegetative keys depends partly on the scale and character of the aerial photographs used. The Anchorage area has been covered by trimetrogon flights made by the United States Air Forces in June and July, 1941 and 1942.[7] Three sets of vertical and matching right and left oblique photographs were used; the scales of the verticals range from 1/30,000 to 1/50,000.[8] The verticals, and some of the obliques, were studied with folding pocket stereoscopes,[9] and the verticals were also employed as bases both for mapping in the field and for the compilation of the map showing classifications of land; the obliques were used for supplementary study.

Variations in character between photographs from different flights may be due to differences in photographic processing or to differences in weather or the declination of the sun at the time of photography or in the time of year (vegetative stage). The tone—the shade of whiteness or blackness—for various types of vegetation is lighter or darker on one or two of the sets of photographs than that which was determined to be the usual tone. Texture—the evenness or smoothness of tone—varies considerably with differences in scale, being finer at the smaller scales.[10] However, these tone and texture differences often made possible a quicker interpretation of a type of vegetation from one set of pictures than from the other two sets.[11]

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[6] "Climatic Atlas for Alaska," *U. S. Army Air Forces, Weather Information Branch, Rept. No. 444*, 1943, pp. 20, 36, and 103.

[7] Information about the availability and cost of U.S.A.F. aerial photographs of Alaska may be obtained from the Commanding General, U. S. Air Forces, AC/AS-2, Air Intelligence Requirements Division, Washington 25, D. C. For persons desiring to use the keys and illustrations as guides during field work it will be advisable to purchase contact prints of the photographs used for the illustrations, the numbers of which are stated in each caption.

[8] Scales of 1/20,000 and 1/30,000 are recommended for this kind of interpretation. For recommended scales of aerial photographs to be used in other types of vegetative interpretation see S. H. Spurr and C. T. Brown, Jr.: Specifications for Aerial Photographs Used in Forest Management, *Photogrammetric Engineering*, Vol. 12, 1946, pp. 131–141; reference on p. 139 (Table 2).

[9] The stereoscope used was the 5-inch, 2-power-lens type manufactured by the Abrams Instrument Corporation, 606 E. Shiawassee Street, East Lansing, Mich.

[10] Variations in texture for photographs with the same scale can be controlled mostly in the processing of the prints, particularly by avoiding enlargement.

[11] Photographs were printed on double-thickness, low-shrink, waterproof paper and had a glossy finish. The glossy finish is the best for obtaining stereoscopic detail; the use of low-shrink paper reduces distortion; and waterproof double-thickness paper lasts longest under field conditions.

THE VEGETATIVE KEYS[12]

Within the Anchorage area seven types of natural vegetation can be recognized and identified on the small-scale aerial photographs: white spruce–birch, aspen, willow, birch reproduction, bush-grass, black spruce, and grass–low bush swamp. The following outline of distinguishing photographic characteristics, or key, applies to the summer appearance of each type. Each key is illustrated by a stereogram that may be viewed in third dimension with a pocket stereoscope. Some of the distinguishing features may not, however, be as apparent in the half-tone illustration as in the original aerial photograph.

WHITE SPRUCE–BIRCH (Fig. 2)

Tone:[13] Gray to dark gray, broken by light-gray spottiness or streakiness. The relatively large areas with darker tones are semidense to dense stands. Individual white spruce trees are dark gray; some individual birch trees are white.

Texture: An uneven medium to coarse stippling, broken by lines of drainage, surface features, or natural lanes.

Stereoscopic Appearance: Tallest of the trees in the Anchorage area. Individual crowns are apparent, those of the white spruce as small dark dots, those of the birch as large light dots.

Shapes of Stands: Irregular.

Distribution: Widespread over the better-drained parts and occasionally extending to margins of swamps. Better growth occurs on warm, moist, and sandy soils. There may be some northern black cottonwood on moister sites.

Tree Types Included:[14] White spruce (*Picea glauca*), white birch (*Betula neoalaskana*), Kenai birch (*B. kenaica*), and northern black cottonwood (*Populus trichocarpa hastata*).

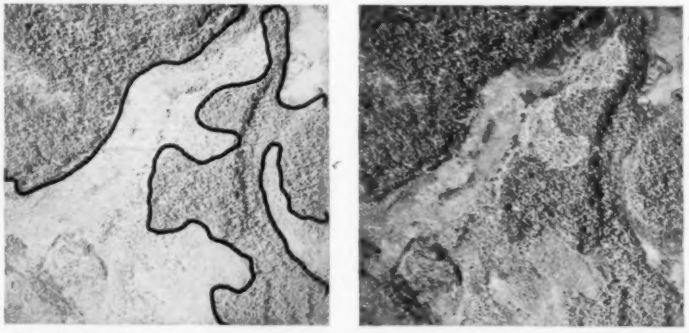

FIG. 2—White spruce–birch. The lines separate the coarsely stippled and darker-toned areas of white spruce–birch trees from bush-grass cover. Scale: 1: 30,000. (Alaska 41, Roll 37X, V-1-11 and V-1-12.)

[12] The general recognition characteristics have been described for several of the vegetative types for which keys are given. See J. A. Russell, F. W. Foster, and K. C. McMurry: Some Applications of Aerial Photographs to Geographic Inventory, *Papers Michigan Acad. of Sci., Arts and Letters*, Vol. 29, 1943, Ann Arbor, 1944, pp. 315–341, reference on pp. 329–332; and H. T. U. Smith: Aerial Photographs and Their Applications (The Century Earth Science Ser.), New York and London, 1943, pp. 120–122.

[13] Descriptions of tone might be standardized by reference to a standard scale of tones. See the Gray Scale in "Map Reproduction in the Field," *U. S. War Dept. Tech. Manual 5–245*, May, 1946, p. 22.

[14] The scientific names of tree types in these keys are from Taylor, *op. cit.*, and C. S. Sargent: Manual of the Trees of North America, Boston, 1933.

ASPEN (Fig. 3)

Tone: Light gray, with irregular small white spottiness or streakiness between clusters. In areas of young reproduction the tone is light gray to dark gray and similar to that of grassy swamp.

Texture: Even fine stippling in individual clusters. In more mature stands the evenness of the stippling is broken by fine lines between clusters, and in areas of reproduction the stippling is so fine as to produce a smooth texture.

Stereoscopic Appearance: Tall trees slightly lower than white spruce–birch type. The fine stippled texture is often not apparent, but stands appear as fine lace with thin lacy fringe. Identification is difficult at scales of 1/40,000 and smaller.

Shapes of Stands: Small, rounded clumps or larger and generally rounded clusters.

Distribution: Usually in relatively pure stands on moist sandy soils on well-drained slopes or benches bordering shallow swamps; occasionally on tops of low hills with white spruce–birch stands or young birch and willow.

Tree Types Included: Aspen (*Populus tremuloides*).

WILLOW (Fig. 4)

Tone: Generally dark gray, but lighter where willow is mixed with birch or spruce–birch reproduction.

Texture: Even medium stippling.

Stereoscopic Appearance: As individual clusters of tall bushes. Identification is possible at scales larger than 1/40,000 but is very difficult where other types of reproduction are intermingled. Identification is easy immediately above the tree line on the Chugach Mountains to the east.

Shapes of Stands: Small, irregular clusters, often of a general linear shape in pure stands. Stands are occasionally broken by spotty clusters of tall trees.

Distribution: On moist, rich soil along edges of streams, on hillsides, and in open woods.

Tree Types Included: Beak willow (*Salix bebbiana*) and feltleaf willow (*S. alaxensis*).

BIRCH REPRODUCTION (Fig. 5)

Tone: Light "salt and pepper" of gray to grayish white.

Texture: Generally even medium stippling except where broken by lines of drainage, surface features, or clumpiness.

Stereoscopic Appearance: As short bushes to short trees according to the date of the photography in relation to the date of burning or clearing. Individual trees are usually apparent or may be identified by short shadows.

Shapes of Stands: Irregular. Relatively large areas are interrupted by swamps, higher lands, or places where fire burned out or was stopped by wind shifts or control.

Distribution: Widespread and usually on the better-drained parts of the burnt areas but varying according to cause, extent, intensity, movement, and control of fire.

Tree Types Included: See white birch, aspen, and willow.

BUSH-GRASS (Fig. 6)

Tone: White to light gray.

Texture: Even fine stippling and often smooth.

Stereoscopic Appearance: No apparent height of vegetation in sharp contrast with tall appearance of occasional trees and exaggerated appearance of heights and slopes of land. This type is often confused with birch-reproduction areas.

Shapes of Stands: Usually small, regular or irregular, rounded patches in hilly areas. Occasionally the areas are large and irregular with small inclusions of other tones.

Distribution: In small basins in hilly areas, possibly with thickets of alder and devil's-club. On the low hills and better-drained level areas this type is often wide-

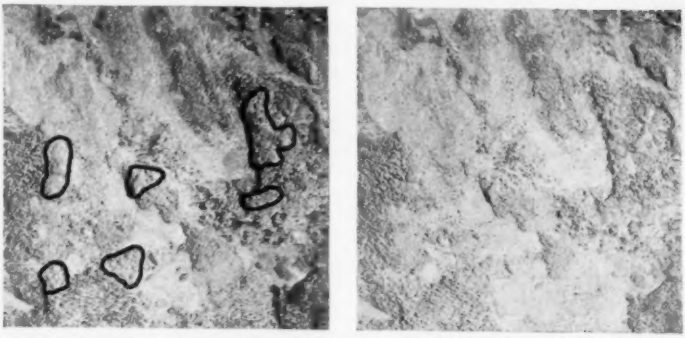

FIG. 3—Aspen. The lines separate the small and finely stippled areas of aspen trees from white spruce–birch trees and of grassland. Scale: 1: 30,000. (Alaska 41, Roll 37X, V-1-11 and 12.)

FIG. 4—Willow. The lines separate the small rounded or linear and finely stippled areas of willow bushes from white spruce–birch trees with small pockets of grassland. Scale: 1: 30,000. (Alaska 41, Roll 37X, V-1-13 and V-1-14.)

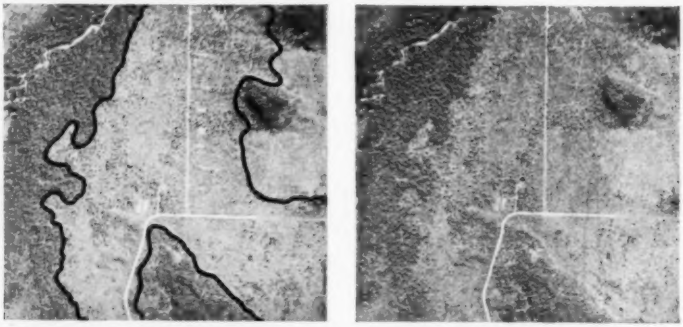

FIG. 5—Birch reproduction. The lines separate the lighter-toned area of birch reproduction in the center from white spruce–birch and of bush-grass cover. Scale: 1: 39,000. (Alaska 41, Roll 39X, V-1-59 and V-1-60.)

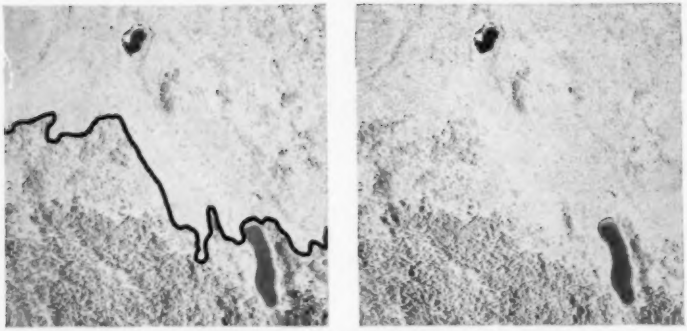

FIG. 6—Bush grass. The line separates the lighter-toned area of bush-grass cover in the top half from white spruce–birch trees. Scale: 1: 30,000. (Alaska 41, Roll 37X, V-1-7 and V-1-8.)

spread under birch reproduction or immature stands of the white spruce–birch type.

Tree Types Included: None.

BLACK SPRUCE (Fig. 7)

Tone: Black with small linear or irregular patches of gray black or gray.

Texture: Fine to medium stippling with occasional streakiness.

Stereoscopic Appearance: As short trees. Individual trees are usually apparent.

Shapes of Stands: Irregular but occasionally linear.

Distribution: On bogs, shallow swamps, edges of deep swamps, or poorly drained edges of streams. The presence of this type usually indicates colder soils and often soils having frozen layers within three feet of the surface.

Tree Types Included: Black spruce (*Picea mariana*).

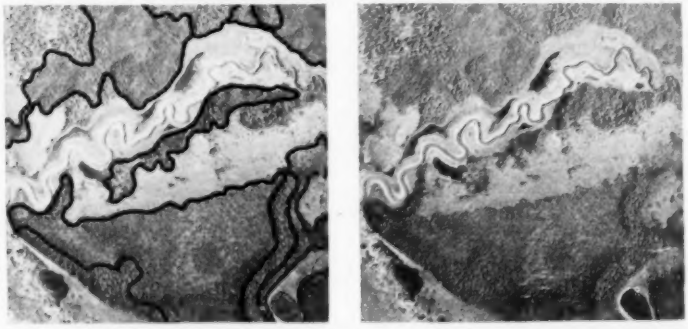

FIG. 7—Black spruce. The lines separate the darker-toned areas of black spruce trees from white spruce–birch trees and grassland. Scale: 1: 30,000. (Alaska 41, Roll 37X, V-1-9 and V-1-10.)

GRASS–LOW BUSH SWAMP (Fig. 8)

Tone: Black in open water and gray in shallower water where long, thin whitish lines may be apparent; light gray to dark gray in low bush swamp and whitish gray in grassy swamp. Patches of open water may be a glaring white if sunlight was reflected directly toward the camera at the time of photography.

Texture: Very coarse stippling or large mottling where open water is present in numerous small ponds; even fine to very fine stippling where the grass–low bush type is solid.

Stereoscopic Appearance: No apparent height of vegetation. Land appears flat except for a few low tree-covered hills on the outwash plain.

Shapes of Stands: Irregular but often generally linear. Occasionally a stand forms a narrow connection between large swamps. A large area on the outwash plain is broken internally by rounded tree-covered hills.

Distribution: Widespread around and between lakes or ponds on level land below 100–150 feet above sea level. In hilly areas this type forms a thin margin around lakes and along poorly drained stream beds.

Tree Types Included: Possibly a few scattered black spruce (*Picea mariana*).

FURTHER DEVELOPMENT OF KEYS

These vegetative keys may be used to interpret aerial photographs of transitional forests between the forests of the south coast of Alaska and those of the

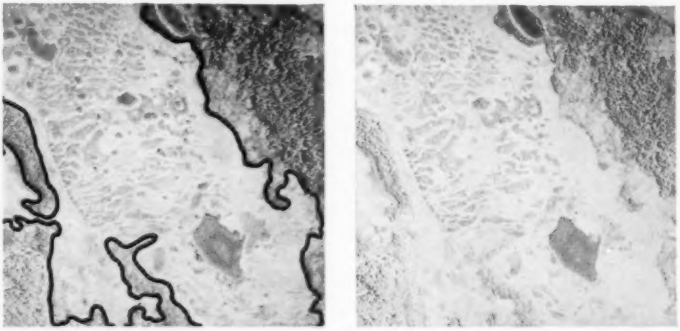

FIG. 8.—Grass–low bush swamp. The lines separate the mottled and lighter-toned area of swamp from white spruce–birch trees. Scale: 1: 30,000. (Alaska 41, Roll 37X, V-1-9 and V-1-10.)

interior. Late in the summer of 1946 they were tested in the interior and were found to be nearly complete for interpretation there, and it is known that they are nearly complete for similar work on the south coast. Needs and possibilities are great for further development elsewhere in Alaska for use in the inventories basic to classifying land for settlement, planning for fire control, and planning for lumbering or mining.[15]

[15] The Alaska Fire Control Service of the Bureau of Land Management made a general inventory of vegetation in the Matanuska Valley in 1940 and 1941 from Soil Conservation Service aerial photographs. The map is on the scale of 1: 15,840. Copies are on file at the A.F.C.S. headquarters at Anchorage and at the Bureau of Land Management offices in Washington, D. C.

The Johnson Elevation Meter—Test Results

By JULIUS L. SPEERT

TOPOGRAPHIC DIVISION, U. S. GEOLOGICAL SURVEY

AT the Eighth Annual Meeting of the American Congress on Surveying and Mapping, a paper was presented by Mr. F. L. Johnson describing the newly developed Johnson Elevation Meter, and the instrument itself was on display at the rear of the meeting hall. Since that meeting, the U.S. Geological Survey has had an opportunity to perform extensive tests on the accuracy of the meter. Some of the results of these tests will be presented in this report.

Described briefly, the meter consists of a sensitive pendulum mounted on a three-wheel trailer which is towed by an automobile. As the vehicle is driven over the route along which elevations are desired, the distance traveled is measured by a count of wheel revolutions and the slope of the road is measured continuously by the pendulum. By means of electronic equipment carried in the towing car, the product of distance times the sine of the angle of slope is integrated continuously and automatically to yield the difference of elevation between successive points along the way. These differences of elevation are read on counters and dials in the towing car whenever the vehicle is stopped for that purpose.

During the summer of 1948, tests were conducted over about 350 linear miles of road in two 7½-minute quadrangles near Valley Forge, Pa., to control an area of approximately 115 square miles. Each road was traversed in both directions to get a double determination for approximately 1000 separate points, involving a total of about 2000 readings. The relief in the area amounts to about 500 feet. There was sufficient geodetic leveling already in the area so that the length of elevation-meter line between bench marks averaged about 5 miles. The elevation-meter leveling was run in relatively small loops, with an average spacing of about 1 mile between junction points. Elevations were determined at an average spacing of about 1500 feet, or at the rate of 3 to 4 points per mile.

After the elevation-meter leveling was completed, fly levels were run over the same routes with a standard spirit level to check the accuracy of the elevation-meter work. The figures which follow are based on the differences between the spirit-level elevations and the meter elevations of identical points, after all necessary adjustments were made in both systems.

Considering the mean values of the elevations determined by the double running with the meter, the average error of all the determinations, without regard to sign, was 0.6 foot. The maximum error of any single determination was 2.9 feet. Ninety percent of all the elevations were accurate within 1.3 feet and 84 percent were correct within 1.0 foot.

When the work was analyzed as a single-run line involving about 2000 individual readings and covering about 700 linear miles, the average error was 0.8 foot and the maximum single error was 5.0 feet. Ninety percent of all the elevations were correct within 1.7 feet and 75 percent were within 1.0 foot.

Presented at Ninth Annual Meeting, American Congress on Surveying and Mapping, Washington, D.C., June 8–10, 1949.

Publication approved by the Director, U.S. Geological Survey.

This test indicated that the elevation meter would probably be able to provide sufficient accuracy for supplemental control in photogrammetric mapping. A project was therefore undertaken in several areas in Tennessee, Mississippi, and Alabama for the running of approximately 2000 linear miles of supplemental vertical control in connection with actual mapping projects. Three classes of work were specified. In parts of the area 1-foot accuracy was needed for the control of 10-foot contours. In some sections 2-foot accuracy was required for the control of 20-foot contours. In one section, the basic geodetic leveling had not yet been done, and it was proposed that an effort be made to supply temporary auxiliary control with the elevation meter until the geodetic leveling could be performed. To obtain the 2-foot accuracy, single-run elevation-meter lines were planned. For 1-foot accuracy, double running was specified. For the auxiliary control lines, triple running was required. Since it was not intended to check this work by other kinds of leveling, specifications were so written that circuit closures could be used as a criterion of the accuracy developed. The required accuracy was obtained in each class of work, but 10 to 15 percent of rerunning was necessary in order to improve circuit closures that exceeded the specifications.

The normal operating speed of the elevation meter is 20 to 25 miles per hour. The average performance on this project was in the neighborhood of 50 miles of line per day. The maximum accomplished in any one day was about 100 linear miles of single run line. The work was accomplished under some of the most adverse weather and road conditions that can be expected in that part of the country. It was clearly demonstrated, however, that the trailer would follow wherever the car could go and would obtain satisfactory elevations while doing so.

* * *

Library of Congress Issues New Map List

A CATALOG entitled "Maps" and comprising a list of 1,000 maps, atlases, and globes published and copyrighted in the United States during the latter half of 1949 has just been issued by the Copyright Office of the Library of Congress. This catalog, which provides, in one place, descriptions of the current maps produced by the map publishers of the country, is the sixth in a series begun in 1947 and available from the Library at 50 cents a copy.

Included in this catalog are maps of oil lands, agricultural products, recreational areas, roads, railroads, parcel post zones, aerial routes, radio networks, rail freight tonnage, real estate ownership, market surveys, density of population, religions and races of the world, mineral resources, and timberlands. The catalog also includes pictorial, celestial, and historical maps, and city plans for both large and small cities, some with less than 25,000 population. In addition to sheet maps, globes, atlases, aerial photographs, and relief models are listed.

The information given for each map includes the name of the person or firm under whose authority the map was prepared, title, area, publisher, and place of publication, series, size, and scale, the day, month, and year of publication, and legal data concerning copyright.

Access to maps is provided, in addition to the authority, by cross-references in the same alphabet from area, editors, cartographers, compilers, and copyright claimants.

Use of Helicopter in Surveying and Mapping

By ELMER E. GUSTAFSON

HELICOPTER DIVISION, BELL AIRCRAFT CORPORATION

IT IS a real pleasure to have this opportunity to tell you a little about the work helicopters have done and can do for you. With your permission, I would like to speak briefly from the record and then show some film footage made in the field which will give you visible proof that the day of wearisome treks up steep mountain trails is rapidly becoming a thing of the past.

Some of you know, I am sure, that the last 12 months have brought an innovation—yes, a revolution to the science of mapping and geophysical survey. I refer, of course, to the helicopter and the speed and comparative simplicity it is bringing to such work. I am not going to tell you how to do your job, as I am far from qualified to discuss the intricacies of mapping, but I am going to tell you how your job has been simplified with the help of rotary-wing aircraft, and then you can evaluate it for yourself.

I have been rather close to helicopters for several years and I find myself thinking of them as being rather commonplace. But quite often I meet someone to whom the helicopter is a strange and fascinating thing, and then I realize that there are still many people who have not seen a helicopter fly and are somewhat mystified by its amazing flight characteristics. I believe, then, that I should give you some brief background so that we can understand each other better.

The helicopter today is young, but it has been—and still is—a most precocious youngster. It was just slightly more than 3 years ago that Bell Aircraft had the distinction of receiving the first Civil Aeronautics Administration license for a helicopter. That gave us the first commercially licensed helicopter in the world.

The first delivery of a helicopter was made in December 1946. Since that time, and with a brand new machine on our hands, we have literally "beat the bushes" to find work for it to do. Finding the jobs, incidentally, was not too hard. The most difficult part was to convince industry, government agencies, firms, and individuals that we had a solution to a problem. I could mention many things our helicopters are doing for mankind in a safer, faster, and more effective way than they have ever been done before, but I am going to forego that temptation and mention just two fields that I know are of interest to you—geophysical and mapping surveys. And helicopters are at the threshold of both of these.

As manager of Bell Aircraft's helicopter oil-survey operations in Texas and Louisiana, I was close to the development of this field, so I would like to devote just a minute or two to these accomplishments. I have some of the same feeling that our great American pioneers and explorers must have had as they picked their way cautiously into new frontiers, because oil has been just that—a new frontier for the helicopter. As I look at the progress which has been made, it is difficult for me to realize that just 2 years ago a helicopter had yet to be used for a geophysical survey.

Presented at Ninth Annual Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 8–10, 1949.

Today we have in our log books a total of 3,000 hours in the air on oil exploration—gravity surveys and seismic surveys—and we have proved to ourselves and, what is much more important, to the oil industry that the helicopter can do the job.

When we started out, we had three questions to answer:

1. Was the helicopter mechanically ready for this type of work?
2. Did it have the flight characteristics and the maneuverability to fit the needs of the oilmen?
3. Could it do the job economically?

The answer to all three has been an emphatic yes.

I am going to give you some figures that will surprise you. Then you will understand why we in the helicopter industry are so pleased and so enthusiastic about our very recent past and our future.

During one of our gravity fill-in surveys, when we were working an isolated marshy area, we had a splendid opportunity to compare the old and the new. A ground crew working next to us was able to establish 16 stations a day. That is about average when the going is rough. With our helicopters we were able to establish more than 100 stations a day, and we have done as many as 115. In effect then, we were able to do in 1 month what it would take ground parties to have accomplished in 5 months. For those of you who are interested in the financial aspects of this operation, the over-all saving was about 40 to 50 percent per station.

In the straight gravity block surveys, marsh buggy crews can establish 300 to 400 new stations a month. The helicopter operation can surpass that figure by more than 1,500. With the seismic survey, it is much the same story. We can provide increased production at lower cost per profile. Production can be at least doubled and, in many instances, tripled. In marshland operations, we can reduce the over-all cost by one-third.

In the Louisiana and Texas operations we have been proud of the fact that the maintenance of the helicopters has not posed a serious problem. Mobile repair shops which followed the helicopters into the desolate areas proved to be more than equal to the task of keeping the machines in the air. In effect, this means that our maintenance has been concerned almost entirely with the normal wear on the helicopter's operating parts, despite the high temperatures and humid conditions under which they flew day after day.

This performance constitutes rather conclusive proof that the helicopter is not the delicate orchid it was a few short years ago. Today, for example, we do the same major maintenance after 300 flight hours that was required 2 years ago after only 25 hours of flight.

Now let us go into your problem. As you know, a Bell helicopter was used in a mapping operation near Pelican, Alaska, last year from June 16 until September 3. During that period there were 28 days during which the helicopter was able to make effective flights, and a total of 260 mountain-top landings were made in 142 flying hours.

I should mention here that weather has to be exceedingly bad to keep a helicopter on the ground. We like to think that we can get our machines into the air when even the seagulls are grounded. Actually, about the only weather that can stop us is dense fog or severe icing conditions. To illustrate the ruggedness of the helicopter, only two forced landings occurred during the operation—one

caused by broken fan belts and the other by carburetor icing—both without mishap.

The mountain landings were made from a sea-level base with operations up to 3,600 feet. Approximately 25 percent were made under adverse conditions, such as gusty winds, intermittent fog, and extremely irregular landing spots. In some cases it was possible to get only two or three of the helicopter's four wheels on the ground. Operational time lost for maintenance was so little that it was considered negligible.

The area covered was 1,000 miles, making the operating cost, with the added convenience of helicopter transportation, $30 per mile. This figure may be compared with $34 per mile for a smaller area which had been worked by ground parties during the previous season.

Another important item is that of foot travel. The engineer often arrives at his station cold, wet, hungry, and exhausted from a climb which took hours. But with the helicopter he travels in 15 minutes as far as he could walk in a day under good conditions, and he arrives at his station fresh and alert, ready to carry out his assignment in a much more efficient manner. J. E. Mundine, area chief of the Denver Engineer Center, Department of the Interior, in a report to the division engineer, summed it up this way: "The major item of importance in this operation is not that the cost is slightly decreased but the fact that the amount of work accomplished for a given period of time is so much greater, which essentially amounts to a personnel increase from a production point of view, because an engineer is able to cover several times as much area in the same amount of time." Mr. Mundine ended this same report by saying, "It is my opinion, based on the past season's operations, that we should plan on utilizing more helicopters in our future Alaskan operations."

You will be interested to know, too, that helicopters are up there again this season, in greater force than last year.

Before closing, I would like to tell you about another geological survey conducted near Canon City, Colo., in March of last year. It was an experimental contract to establish the feasibility of utilizing helicopters to transport personnel in survey mapping work. The operation was observed by Earle J. Fennell, Chief of Plans and Estimates, Department of the Interior, and Robert O. Davis, Division Engineer in charge of the Denver Branch. During this operation landings were made at altitudes of 11,000 feet.

As an example of the work accomplished, on one occasion four crews were delivered to various scattered locations by 10 o'clock in the morning. To have reached each of these points on foot would have taken at least a day of climbing under the best of conditions.

Joseph S. Dunne, who is now in charge of our oil exploration operations in Louisiana, was an observer for Bell throughout this operation, and he summarizes it by stating that, "A tremendous amount of work was accomplished in both areas and the operation was successfully concluded."

My purpose in speaking to you has been to report on the work helicopters are now doing for your profession. If I have awakened in you an awareness of the importance of this type of transportation to the making of geophysical and mapping surveys, I have been helpful to you. I know you are interested in better, faster methods of doing your job, and through the use of the helicopter I am convinced that we have made a tremendous stride in the right direction.

If you want an aerial vehicle that can take you to isolated locations quickly, that can fly in almost any kind of weather, and that can do the job faster at reduced cost, the helicopter is your answer.

By EARLE J. FENNELL

U. S. GEOLOGICAL SURVEY

Mr. R. O. Davis was originally scheduled to give this talk. However, he has found it expedient to inspect our field parties in Alaska and is probably even now soaring about the Arctic sky in a helicopter, while I, poor earth-bound mortal, am elected to be his substitute on this platform. Before we are through, you will undoubtedly wish Davis were here and I were in a helicopter.

Government mapping organizations in general, and the Geological Survey in particular, owe a hearty thanks to the various representatives of helicopter companies. In my opinion, this rapidly growing industry represents the finest in our American system of free enterprise. It is our experience, in seeking advice on helicopter operations, that the representatives of the various companies have subordinated their individual interests to the greater common interest of the development and expansion of the rotor wing principle of flying as a whole. I recall with pleasure the many meetings held with Jack Beigle, of Sikorsky, and Dave Postle, formerly with Bell. Their advice, and the timely assistance of Munro Brown of the Aircraft Industries Association and Bob Fischel of the Roto-wing Air Service here in Washington, helped immeasurably in setting up specifications for our initial use of the helicopter. When we began our negotiations the only licensed craft were the Bell and the larger Sikorsky. It is my understanding that Hiller has licensed the 360 for commercial use and Kaman has licensed the twin rotor ship that he has developed.

The Geological Survey's initial use of helicopters for transporting men and instruments as an aerial taxi, or a pack mule with wings, was about 15 months ago. We let invitations for helicopter operations for a 30-day-or-so project in Colorado. It should be emphasized that although this was our initial attempt, it was not in any sense an experiment, since the adaptability of this type of aircraft to the transportation of men and material had been quite well proven by commercial operators and by other federal agencies, such as the Forest Service and, of course, the various air arms of the Department of Defense.

The Fabick Aircraft Company of St. Louis, Mo., was the successful bidder on the first contract. They towed a new Bell 47D on a specially built trailer to Canon City, Colo., and set up shop at the Royal Gorge Airport. The operation there consisted of flying observers on reconnaissance for triangulation and transporting instruments, men, and equipment to various sites for triangulation stations in the area. The airport was at 6,500 feet, or thereabouts, and the weather was cold with a gusty wind. All the take-offs were "jump," without forward run, and all landings were hovering type. We established numerous triangulation stations in the area ranging from 7,300 to an extreme of 10,200 feet above sea level. The landing at 10,200 feet was definitely a tricky operation, and I do not believe that Mr. Gustafson or the representatives of the Bell Company would recommend it as an everyday occurrence. We did fly the lightest

man in our party to an elevation of 10,200 feet and let him off but it was necessary to make 2 return trips and landings before he could complete his work and be picked up.

The snow was deep on that mountain peak, and we gave him about 2 hours to reach the triangulation station. However, he did not have a pair of snowshoes along, and it took him longer than he anticipated, so when Bob Angstadt, the pilot for Fabick, returned at the two-hour interval, the observer was not yet back at the landing place. He trailed him through the snow, found where he was, and landed at that point. That made his second landing. Then he took off again and returned about 45 minutes later to pick up the observer.

It was necessary, of course, during the flight to the triangulation station, which in this instance lay south of the Royal Gorge, to fly over the Gorge with its rather treacherous downdrafts, but the flights and landings were accomplished on the high peak without particular difficulty.

The operation at Canon City was entirely successful, and the Fabick Aircraft Company moved its ship from there to Paradox, Colo., on the western slope, where the helicopter crew, performing in an entirely satisfactory manner, moved triangulators and supplemental control men about on that project.

The Colorado operation was a trial run for a larger operation in Alaska. The strategic and economic importance of the Territory makes it desirable to expedite its mapping. The time involved in moving from station to station is a big factor in surveying operations, as any flat-footed engineer can testify, and we hope to speed things up by keeping our transportation equipment as modern as our compilation equipment.

Toward that end, we issued bids for the use of two helicopters in the vicinity of Juneau, basing one at Pelican on Chichagof Island and the other at Fairbanks for operation in Central Alaska. The terrain varied from rocky, mountainous terrain to marshy, inland areas. The elevation of the landings was from sea-level to approximately 7,000 feet, and the temperature range was from minus 10 degrees to plus 85 degrees. The summer's operation was completed to our entire satisfaction. This year the Geological Survey has four helicopters under contract, three for the Topographic Division in Central and Southeastern Alaska, and one for the Geologic Division at Healy.

The Army Map Service is using a commercial helicopter in its work on the Seward Peninsula, for transportation of men and material. The Coast and Geodetic Survey is using three helicopters on its current Alaskan operations.

All in all, the helicopter principle of air travel is fairly well represented in activities related to surveying and mapping, and prospects for increased usage of these machines in rough, isolated areas appear to be good. In the United States the road pattern is sufficiently dense to provide rapid transportation by more conventional methods, and there may be only occasional use by the Geological Survey of helicopters in the United States.

Some further development could be made on the service of supply for our helicopter operations in Alaska. Perhaps it might be advisable to have a combined fixed and rotor wing operation, basing near a convenient lake, and utilizing the greater load-carrying capacity of the fixed-wing amphibian for the service of supply.

We look forward to the development of such routine problems, and we look forward to an expanded use of the helicopter. I think that increase of power in

small ships—the industry in general is working on this angle—will raise the ceiling for the jump take-offs and hovering landings that are so necessary where there is inadequate space to turn a wheel upon landing. This will widen the scope of helicopter utility by bringing the higher peaks within its range.

* * *

SHORT REFRESHER COURSE IN SURVEYING AT VIRGINIA MILITARY INSTITUTE

NEARLY A HUNDRED SURVEYORS from all sections of the state of Virginia attended a 5-day refresher course in Surveying conducted by the Department of Civil Engineering of the Virginia Military Institute on January 23–27, 1950.

The Surveyor's School, which consisted of classes and lectures in the mornings and afternoons with showings of training films on mapping and surveying instruments in the evenings, was sponsored by the Virginia Association of Certified Surveyors and the Virginia Department of Highways, with assistance from the Industrial and Vocational Training Division of the State Board of Education.

Assisting Col. R. A. Marr, Jr., head of the Department of Civil Engineering and director of the School, in the classroom instruction and lectures of the refresher course in surveying were Lt. Col. J. H. C. Mann, associate professor of civil engineering, Maj. Walter B. Wilson, assistant professor of civil engineering, and Capts. Samuel W. Dobyns and Robert E. Anderson, instructors of civil engineering.

No special educational qualifications were required of the trainees, though the program of instruction was designed for land surveyors and highway surveyors of considerable experience who desired training in calculating surveying problems and sought advancement of their profession by the consideration of the ethical and legal aspects of surveying. The course content was determined from requests of Virginia surveyors.

The American Society of Photogrammetry and the American Congress on Surveying and Mapping furnished displays, and mapping films were supplied by the U.S. Geological Survey and the Coast and Geodetic Survey.

D. N. Huddle and J. E. Harwood, of the Division of Location and Design of the Virginia Department of Highways, addressed the one hundred trainees on The Plotting of Data, on Tuesday morning, and the afternoon session was concluded with guided tours of the Institute grounds and buildings, including the famous military museum.

Wednesday morning, John H. Foster, retiring President of the Virginia Association of Certified Surveyors, addressed the School on Errors and Omissions in Land Surveys, and E. G. Spies, associate professor of law at the University of Virginia, led a panel discussion on The Legal Aspects of Surveying, with A. H. Pettigrew, right-of-way engineer of the Virginia Department of Highways, and Harry Myers, field engineer of the Virginia Gas Transmission Company.

Thursday's program was opened with a panel discussion on the Registration of Surveyors, led by Ernest H. Williams, director of the Division of Professional and Occupational Registration, who was assisted by G. Hubard Massey, member of the Board for Examination and Registration of Surveyors, and John H. Foster.

Prof. G. Brooks Earnest, of Case Institute of Technology, addressed the surveyors on Reasonable Standards of Accuracy, and Brig. Gen. H. B. Holmes, Jr., planning engineer of the Division of Planning and Economic Development of the Virginia Department of Conservation and Development, gave addresses on the Virginia Coordinate System and Sources of Information. E. Lawrence Chandler, assistant secretary of the American Society of Civil Engineers, delivered an address on Professional Ethics.

Surveying in Our Engineering Curriculums

By HARRY BOUCHARD

PROFESSOR OF GEODESY AND SURVEYING, UNIVERSITY OF MICHIGAN

IN 1936, Prof. Otto S. Zelner made a study of the teaching of surveying in summer schools and camps conducted by our engineering colleges. The results of his studies were published in the April 1937 issue of the *Journal of Engineering Education*. According to his report the University of Michigan and Cornell University were the pioneers in summer surveying camps, having established the first ones in 1874. Dartmouth started summer surveying classes in 1870, which appear to have been operated from its campus rather than from a camp.

According to Prof. Zelner 12 camps were established before 1900, 8 between 1900 and 1909, 11 between 1910 and 1919, 14 between 1920 and 1929, and 9 from 1930 to 1937—a total of 54. In 1937, summer courses in surveying were taught at 19 colleges. More recent investigations by Prof. Russell C. Brinker of the University of Southern California indicate that five new camps have been established since 1937. Summer courses have been added at two additional schools, and six other institutions are either contemplating camps or have decided to put them into operation for the first time this coming summer. There are, therefore, about 60 summer camps; in addition, summer courses are taught at about 24 other colleges.

Prof. Brinker also investigated the amount of time devoted to surveying in our engineering colleges. He found the average to be 11.4 credit hours, which represents about 8 percent of a 4-year engineering course. It is interesting to note that there is a very wide variation in the amount of time required—from an unbelievably low 1 hour at Brown to highs of 24 at Ohio State and 25 at the University of Cincinnati. It is probable that some of the apparent extremes are caused by the different methods of evaluating scholastic credit and by the fact that some institutions operate on a 2-semester basis and others on one of 3 terms. So far as credit for camp work is concerned, the general policy appears to be that of granting one credit for each week spent in camp. This is the equivalent of a student's receiving from 15 to 18 credits for a semester's work on the campus.

What should be accomplished in the time assigned to the teaching of surveying and what should be expected from our engineering graduates? What should they be qualified to do? If one enters the construction field where a limited knowledge of surveying may suffice, it is probable that his employer will expect him to have sufficient competence in fundamentals to be able to measure distances accurately, set up a level or transit expeditiously, make the necessary readings quickly and accurately and record them neatly so that others can interpret them correctly, and detect and eliminate mistakes in his work. He should have a knowledge of the sources of errors in field measurements, so that time will not be wasted in unnecessary refinements; yet his measurements should be sufficiently accurate to serve their purpose. In addition, some knowledge of the following may be either very essential or desirable, depending upon the circumstances:

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(1) Testing and adjusting surveying instruments.
(2) Computing and staking out horizontal and vertical curves.
(3) Cross sectioning and setting slope or grade stakes.
(4) Computing earthwork volumes and preparing mass diagrams.
(5) Determining the azimuth of a line by astronomical observations.
(6) Executing simple triangulation when a distance cannot be measured directly.
(7) Making topographic surveys by the stadia or planetable method.
(8) Using aerial photographs, at least for preliminary surveys.
(9) State Coordinate Systems and control data, both horizontal and vertical, which can be obtained from government agencies.
(10) U.S. System of Public Land Surveys and the principles involved in property surveying.
(11) Drafting, with the ability to do a reasonably decent job.

This covers practically the entire field of basic surveying. Omitted are the specialized subjects of hydrography, photogrammetry, geodesy, mapping of large areas, mine surveying, and stream gaging. The latter is included as a part of surveying at some schools.

How is all this to be taught in the average time allotted by our engineering schools? At the University of Michigan three courses, totaling 11 credit hours, are required for students of civil engineering. This is just below the average of 11.4 (later corrected to 11.3) found by Prof. Brinker.

Three-elevenths of the time is spent on fundamentals—taping, differential and profile leveling, grade stakes, horizontal angles, closing a traverse by the azimuth method, computing latitudes and departures, distributing any reasonable error, and computing the area from the coordinates and by double meridian distances. Circular curves are computed and staked by deflection angles and by tangent offsets. The elevations of points on parabolic vertical curves are also calculated.

Upon completion of this course the student has a knowledge of essential surveying operations, but he has not had enough field practice to give him the speed and confidence gained only by additional practice.

The second course covers the textbook portion of topographic mapping and consists of earthwork, the adjustment of instruments, triangulation, hydrographic surveying, U. S. Public Land Surveys, constructing and finishing maps (including the commonly used projections), and State Coordinate Systems. This material must be covered in thirty 1-hour classroom periods.

In an equal number of 4-hour drawing-room or field periods, the students, after preparing a contour map from provided elevations and a planimetric map from aerial photographs, using slotted templates and a Sketchmaster, make a planetable survey of an area adjacent to the campus.

For 50 years an 8-week summer surveying camp was a required part of our civil engineering curriculum. About 25 years ago it was made optional and since that time approximately half of the men who later graduated attended the camp. The others completed only the work given on campus.

The camp now is compulsory again—but for only 4 weeks of surveying, the other 4 being devoted to a course in geology. It is also possible for the student to spend the 8 weeks surveying and to take the geology course on the campus. It is obvious that but half as much can be done in 4 weeks as is possible in 8. Consequently, those who elect the 4-week course must be content to sacrifice something. The men work in parties of four. Past practice has been to give each man on

field assignments a full day as instrumentman, but in general that time has now been cut to a half day. Preparation for astronomical observations for time, latitude, and azimuth was made possible by an evening course given during the first 5 weeks of the camp. The aim of the camp has been to give instruction under conditions which as nearly as possible approximate those encountered by the practicing engineer.

It thus appears, the best that employers of young graduate civil engineers can hope for is that these young men will be reasonably well grounded in the principles of surveying. Those who come from schools where only the average number of hours are devoted to the subject will not have had as much field practice as would be desirable and they will be lacking in other respects. If they have come from schools where still less time is spent on surveying, they will be correspondingly handicapped.

There are, of course, other courses in surveying, which may be taken as electives. The University of Michigan offers additional work in municipal surveying, photogrammetry, geodesy, least squares, and railroad surveying. A limited number of electives are taken by students who, because of original entrance deficiencies, are compelled to spend an extra semester or two in school or who expect to enter a field where additional training is imperative. The employer must face the fact that so long as the demand for the inclusion of more and more courses in our engineering curriculums continues—and I see no signs of any diminution of that demand—he must be content with men less thoroughly trained as surveyors, and devote more of his time to on-the-job training of the young engineer.

* * *

NORTH AFRICA'S FIRST AIRBORNE MAGNETOMETER SURVEY

Flying of North Africa's first airborne magnetometer survey was recently completed by Aero Service Corporation of Philadelphia. Approximately 20,000 square kilometers in north-central Tunisia were flown to begin Gulf Exploration Company's exploration program in the area.

Magnetic mapping of the area was done in less than 30 days with the new, improved, high-sensitivity Gulf airborne magnetometer. A record accurate to variations as small as 1 gamma was obtained. The data will be compiled by Aero Service Corporation in magnetic intensity maps at a 5-gamma contour interval. The maps will be delivered this year for study by Gulf geologists and geophysicists. Aerial photographs made during the course of the survey will also be studied stereoscopically.

A specially outfitted Douglas twin-engine transport was used for the survey. It was the same plane Aero Service employed in last year's oil survey in Mozambique and in mineral surveys in the Union of South Africa. In 1947 the plane and some members of the Tunisian survey staff performed a large-scale magnetometer survey of the Bahamas.

Surveys and Maps Required at the State Planning Level

By ELIZABETH M. HERLIHY

CHAIRMAN, MASSACHUSETTS STATE PLANNING BOARD

ON JUNE 3, 1944, I had the privilege of addressing this same group, from this same platform, on practically the same subject as that assigned to me here this morning—"Surveys and Maps Required at the State Planning Level." Perhaps I should feel complimented at thus being asked to give a repeat performance were I not uncomfortably conscious of the fact that reactions, like motives, are seldom unmixed.

I have in mind, for instance, the story of the earnest young preacher who was assigned by his superiors to conduct services from time to time in a variety of places, each one more or less remote from the others. The rumored reaction was not entirely favorable. Eventually, the young man was summoned to a conference and questioned as to the result of his labors; whereupon he assured his interrogators that in each instance his audience must have been fully and completely satisfied with his initial appearance, for they had never even remotely suggested that he should come again. It could be that my participation in your program five years ago was *not* entirely satisfactory and that I am now being given a further opportunity to redeem myself. For that indulgence I am most grateful.

My primary function here today, as I understand it, is to establish a common meeting ground between your work as a surveying and mapping organization and my work in planning. Like many other conditions which are generally obvious and which exist by tradition or by common acceptance, it is not an entirely easy task to prove, by chapter and verse, that mapping and planning, while independent activities and not synonymous by any means, are nevertheless closely related and that each should serve to supplement and strengthen the other.

MAPPING AND PLANNING FOR COMMUNITY NEEDS

Perhaps the most definite and outspoken exponent of the use of maps in planning work was the late Edward M. Bassett of New York City. In his book on the "Master Plan" he points out the things that an individual may do. He may hunt and fish, plant seed and raise animals, and build houses, stores, and factories; but the time soon comes when community demands outgrow individual activities, and the need arises for adapting land areas to common purposes. This only a community can do, for the benefit of the community, through the enactment of laws; and these laws constitute community planning legislation.

The seven elements of community land planning Mr. Bassett defines as streets, parks, sites for public buildings, public reservations, zoning districts, routes for public utilities, and pierhead and bulkhead lines. Each of these elements relates to land areas; each has been stamped on land areas by the community for community use; *each can be shown on a map.* If a subject does not conform to these three requirements, then Mr. Bassett maintains that it does not come under the heading of community land planning. Building codes, factory regulations,

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health and housing laws, budgets, taxation, assessments and other features are all recognized as important in their respective places, but dismissed from present considerations because "they cannot be shown on a map and therefore do not constitute elements of the plan." In other words, a map is the vehicle by means of which a plan emerges from the mind of the planner and takes on definite form and substance consistent with community planning legislation.

The planning process, developed as a result of this community planning legislation, has been defined as consisting of four successive steps:

(1) Securing or compilation of adequate basic data;
(2) scientific analysis of the data thus assembled;
(3) preparation of comprehensive or guiding plans; and
(4) enforcement or effectuation of the ensuing proposals.

No one of these steps can hope to achieve any substantial measure of accomplishment by itself. In actual practice the interdependence of the first three of these requirements is so pronounced as to be almost axiomatic. The collection of basic data—the first step—is no more than an interesting pastime except as it makes available the material necessary for the research and study contemplated in the second step to be used as a foundation upon which finally may be projected, as the third step, desirable and comprehensive plans of development. The carrying out of these plans—the fourth step—is primarily an administrative function and is dependent upon the existence of appropriate legislation, the availability of funds, and the cooperation of public officials and the public.

Having agreed that the compilation of basic data is the first step in the planning process, the question immediately arises as to the type of information essential to sound procedure, and the ways and means by which such information may not only be obtained but made available for analysis. Some of this information may already be available through traffic counts, origin and destination studies, and surveys with regard to school facilities, housing, recreation areas, public utilities, and other features. Detailed information concerning population including growth, distribution, composition, trends, and birth and death rates, as well as health, welfare, and social service statistics, is essential to the preparation and development of a comprehensive program. It is the job of the planner to gather together whatever is available from other sources, to coordinate the material, and to supplement it by other studies wherever needed.

At this point there is general agreement among all workers in the planning field that a good base map of the area under study—local, regional, or state—upon which detailed material may be plotted and made available in graphic form, is of primary importance. Such a map will serve as a sort of proving ground upon which the various data with regard to physical, social, and economic considerations, as they are assembled or compiled, may be charted and studied in relation to existing conditions as a basis for the formulation of plans for future growth and development.

The mechanics of securing such a base map upon which to record existing conditions or proposed plans, in itself however, poses a more or less difficult question in many instances. Many municipalities, particularly in the less densely populated areas, naturally hesitate to incur the expense of an actual survey. The complete coverage of the State by the U. S. Geological Survey and the publication of topographic sheets on a scale of $\frac{1}{2}$ mile to the inch have afforded a simple and entirely practicable means of obtaining a generally satisfactory and adequate base map at relatively small expense. A bulletin describing in detail the pro-

cedure which may be followed, together with an index map of the State showing the layout of the geological sheets in relation to city and town boundaries, has been prepared by the State Planning Board and distributed to the local communities. Obtaining the necessary geological sheet or sheets, combining them if need be, and making photographic enlargements and tracings to the desired scale are relatively simple, inexpensive and satisfactory processes. Duplicate tracings on cloth can be made photographically, or prints of the tracings can be made by any of the well-known processes. Special data may then be added as a basis for a Master Plan, for general planning and zoning studies, for use by assessors and by highway, water and sewer departments, or for a variety of other uses where an accurate and up-to-date map of the community is desired. This method has been followed with entirely satisfactory results in a number of our Massachusetts communities.

Assuming the existence of a base map of proper size and scale, therefore, and assuming that the planning agency has assembled, plotted, and analyzed adequate information with regard to present conditions and probable future needs, the scientific combination of these two elements will produce what is sometimes referred to as a Master Plan. Far from being a Frankenstein, as it has been looked upon at times by uninformed groups, a Master Plan can do nothing more than afford a record of existing conditions, information with regard to present and probable future needs, and suggestions as to possible methods of procedure. The only power it has is that to be derived from the validity of its proposals.

MASTER PLANS AND OFFICIAL MAPS

It might be well at this point for the sake of the record to emphasize the difference between a Master Plan and an official map. Again I quote Mr. Bassett: "A Master Plan is nothing more than the easily changed instrumentality which will show a commission from day to day the progress it has made." It is the property of the planning board, and, while it may be a matter of public record, it has no binding force and may be added to or changed from time to time. The official map, on the other hand, insofar as our section is concerned—and I think this is generally true in other sections as well—is adopted by the local governing body and can be changed only by following certain established procedures. It is therefore much more restrained in its content than a Master Plan and in some instances carries with it a protective provision designed to prevent the erection of buildings between lines of proposed new streets or widened existing streets. This means that it is entirely essential that the street lines of the official map be accurately located. In addition, the official map may include the location of existing or planned parks or other public open spaces. In some localities it may show the lines of streets on plats of subdivisions that have been approved by the planning agency, as well as the lines of planned streets located on plats prepared by the planning agency. While this material may be limited in extent, its chief value depends upon its accuracy, since it stands as a pattern for successive municipal governments to follow and for the guidance of real estate developers and other land owners. In Massachusetts, planning boards established under present enabling legislation "shall" make a Master or Study Plan of the community, while cities and towns where such planning boards have been established "may" adopt an official map; thus a definite distinction is drawn between mandatory and permissive functions.

The legislative act establishing the Massachusetts State Planning Board pre-

scribes that it shall prepare, and from time to time revise and perfect, a Master Plan for the physical development of the Commonwealth. In keeping with this mandate, there is at the present time across one side wall of our conference room a map of the entire State on a scale of one mile to the inch. Since our State—or our Commonwealth, as we like to and rightfully do call it—extends 150 miles from east to west, it requires a map approximately 15 feet long, taking into consideration our irregular coastline. On this map are shown in colors city, town, and county boundary lines; the entire street pattern of each community minus the street names; numbered routes of the major highways and parkways; public, semi-public and quasi-public lands, including parks, reservations, forests and airports; railroads, both passenger and/or freight; and waterways, streams, lakes, and ponds. Also shown on this map are the boundary lines of U. S. Geological Survey sheets. Recognizing that a consistent technique in the mapping of basic planning data is much to be desired, we have adopted in symbols and in colors the procedure suggested some years ago by the National Resources Committee and recommended by other groups as a realistic attempt to reach something approaching uniformity of usage.

Not only is this basic data map the starting point or nucleus for our own proposals, but it also serves to crystallize the thinking of the local planning groups, who, in their turn, are directed by legislative act to make a Master or Study Plan of their respective cities or towns.

So far as specific activities are concerned, the planning board, through its power of subdivision control, probably exerts its greatest single influence on the welfare of the community. Land subdivision is the first step in the process of community building. Once land has been cut up into streets, blocks, and lots and been properly recorded, a definite pattern, which it is difficult to change, has been imprinted upon the land. For generations the occupants of such land will be influenced by the character of its design. It is vitally important, therefore, that the decision of the planning board in dealing with subdivision problems should be predicated upon accurate information, together with a high degree of wisdom and of vision.

While the Massachusetts State Planning Board per se has no direct jurisdiction over local subdivision developments in our Commonwealth, it is required by statute to advise, assist, confer, and cooperate with the local planning agencies. At the present time there are 193 local planning boards in the State, representing 93 percent of the total population. Of these, 118 have been authorized by vote of their respective communities to exercise jurisdiction over subdivision developments, an authority which in previous years had been vested in a board of survey.

LAND SUBDIVISION REGULATIONS AND RECORD PLATS

The Enabling Act under which these 118 local planning boards are functioning provides that every person, before making a subdivision in any city or town, shall submit a plan of the proposed development to the local planning board for its approval, although provision is made for a preliminary plat of less rigid requirements than the definitive or final plan. The planning board before approval may require provision for the construction of such ways and public utilities as in its opinion will justify the subdivision and may require a bond to secure proper performance. It may also require open areas suitable for parks, playgrounds, and recreation purposes or for providing light and air. It shall require

that the ways shown on the plat have proper grades and widths and be located to afford light, air, and access, including access of fire-fighting equipment.

In conformity with these requirements, both mandatory and permissive, the suggested subdivision regulations provide that the preliminary plat may be drawn on paper with pencil, preferably on a scale of 1 inch equals 100 feet. This preliminary plat shall show, in addition to information regarding ownership of property and abutters, the existing and proposed lines of streets, ways, easements, and public areas within the plat; the proposed system of drainage; lot lines with approximate dimensions, locations, names, and present widths of adjacent streets; topography with 2-foot contour intervals; and profiles of proposed streets.

The definitive or record plat, it is further suggested, shall be prepared by a competent designer or surveyor and shall be clearly and legibly drawn in black India ink upon tracing cloth in suitable over-all dimensions. The drawing shall be at a scale of 1 inch to each 50 feet.

In addition to the information contained on the preliminary plat, the record plat shall show also the location of all permanent monuments, together with sufficient data to determine readily the location, bearing, and length of every street and way line, lot line and boundary line, and to reproduce same on the ground, all bearings being referred to true meridian. Not only minimum street widths and grades are suggested but also the cutting back of street lines at intersections, and various other admonitions with regard to design and the preservation of natural features.

On the basis of the data submitted, the responsibility rests upon the planning board to determine whether the land can be used for residential purposes without danger to health and whether the street system proposed conforms to the Master Plan. This is no transitory responsibility, for inherent in the practice here briefly outlined is contained the protection afforded the citizen in purchasing a building site with the assurance of its usability and suitability and the general benefit to the community resulting from sound practices in land-use and subdivision development. Every time a new land subdivision, with its streets, blocks, lots, and open spaces, is proposed and developed, a piece of city building has been accomplished, a definite pattern has been imposed upon the land, and a portion of the community has been planned. As has been said, in the final analysis our nation is just one community added to another until the splendid total makes us what we are today.

If the character building of a single individual is considered a problem worthy of the best efforts of educators and psychologists—and with this point of view I am in full agreement—then is it not reasonable to assume that a development which shapes the character of a community is of even greater importance and more far reaching in its possibilities for good or evil results?

At the same time, it is highly important in comprehensive planning work that subdivision and zoning regulations should be correlated. Lot widths and depths, as specified by subdivision regulations, should be such as to permit set-backs and side and rear yards of the dimensions required by the zoning ordinance. Conflict can but produce confusion. Zoning and subdivision regulations should be regarded as related instruments for achieving harmony between themselves and conformity to the pattern and the standards of the Master Plan.

The existence and adequacy of enabling legislation is of course the first step in a comprehensive zoning study. Secondly, the data and studies fundamental

to planning work are an important part of the background information required for a competent zoning plan. In addition, certain specific studies are generally considered essential to the preparation of a zoning ordinance, although there is no statutory requirement that such studies shall be shown on a map. Information with regard to the existing use of buildings and land, the height of buildings, the width of streets, and a variety of other data having to do with lot sizes and present occupancy is essential to the preparation of an efficient, well-rounded zoning plan. While there may be ways and means of making this information available, statistically or otherwise, without the use of maps, it is certainly more usable and more intelligible to the average mind in map form.

USE OF MAPS TO SHOW ZONING DISTRICTS

The Massachusetts Zoning Enabling Act sets forth that municipalities may be divided into "districts," and local communities in setting up these "districts" usually—not always—specify that they are as shown on a map accompanying the zoning ordinance or bylaw. In a recent opinion handed down by the Massachusetts Supreme Judicial Court, the question at issue being whether a particular map had been filed as a part of the zoning bylaw, the Court stated:

> "The City Council could adopt an ordinance complete in itself or they could, as they did, in this instance, adopt one fixing the location of the various districts by a map."
>
> Again, "The statute . . . authorizing the passage of zoning ordinances, does not require a City Council to adopt a zoning map."

Such a zoning ordinance "complete in itself" has been adopted in a limited number of our communities and usually consists of a detailed description of the districts, using the street names, dimensions, and, in some instances, distances. One description which I have selected at random, substituting street names of my own, defines an industrial district as follows:

> "The triangular parcel of land which lies between East and West Maple Street and extending northerly from a straight line drawn from a point in the westerly line of East Maple Street, opposite the center of Elm Street, to a point in the easterly line of West Maple Street, which point is opposite the center of said Birch Street."

I submit that the public welfare, which after all is the chief objective of all zoning, to say nothing of the time and patience of the administrative officials, would be better served by a map showing the location in question than by a confusing, though no doubt accurate, description "complete in itself."

In these few paragraphs I have attempted to bring out the high lights in certain phases of planning work, about which volumes have been written by much more competent prototypes than I. I do not hope to have told you anything new. Be that as it may, the great challenge of our work today is that it is never ending. There is always an interrelationship with other projects and other people and an envisioning of something more to be accomplished. While we may no longer have the frontiers of a continent to conquer, there still remains work for every man and woman of vision and courage on the frontiers of a better civilization. It is only by accepting the challenge that is presented to us, therefore, and by working shoulder to shoulder with others in parallel lines of endeavor that we may hope to measure up to our opportunities and to justify the confidence presently reposed in the planning profession as an integral part of State, regional, and local government.

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

MOSAIC MAPS. H. R. Cochran, *N. Z. Survey Draughtsmen's Journal*, September 1949. (Gives draftsmen a brief description of mosaic maps and also of the requirements designed to ensure their production.)

MAPPING ORGANIZATION AND METHODS OVERSEAS. R. G. Dick, *N. Z. Survey Draughtsmen's Journal*, September 1949. (Describes the author's visit to various mapping agencies in America, England, and Switzerland.)

POLAR NAVIGATION. K. C. Maclure, *Arctic*, December 1949. (Deals with the measurement of direction in polar latitudes.)

ENGINEERING EXPERIMENT STATION NEWS. *Ohio State University*, December 1949. (This issue is comprised of discussions concerning the importance of engineering drawing to the engineer, and various other phases of the subject. Single copies may be obtained free of charge from the Engineering Experiment Station, Ohio State University, Columbus, Ohio.)

MAPPING. J. P. Arthur, *New Zealand Surveyor*, December 1949. (Presents present-day mapping problems, procedures, and methods.)

AN ANALYTICAL KEY TO MAP PROJECTIONS. Hugh E. Spittal, *The Journal of Geography*, December 1949. (Presents the development of a key by which the name of the projection of any small-scale map can be readily determined.)

PHOTOGRAPHIC LABORATORY DEVELOPS UNIQUE CAMERA. A. D. Keogh, *CADO Technical Data Digest*, 1 January 1950. (Describes the "Zenith" camera, which shoots up instead of down. Developed for making aeronautical charts from aerial photographs.)

CHARACTERISTICS OF MEASURED WAVE ACTION ON THE BASIS OF THE FREQUENCY DISTRIBUTION OF WAVE LENGTH, WAVE HEIGHT, AND STEEPNESS. *The Bulletin of the Beach Erosion Board*, January 1, 1950.

AIR NAVIGATION IN HIGH LATITUDES. A. J. Hagger, *The Polar Record*, January 1950. (Discusses problems in polar navigation based on experiences by a member of the crew of the aircraft *Aries* during Arctic flights.)

PLACE NAMES IN THE SOVIET ARCTIC. Terence Armstrong, *The Polar Record*, January 1950. (Discusses the methods used by the British and American map- and chart-producing agencies in treating the problem of Russian place-names.)

STUDY OF SEA ICE IN THE SOVIET ARCTIC, 1920–45. *The Polar Record*, January 1950. (Contains a description of the study of ice conditions made by the Arctic Institute at Leningrad.)

STRUCTURE OF THE EARTH'S CRUST IN THE CONTINENTS. B. Gutenberg, *Science,* January 1950. (Discusses the velocity of earthquake waves in the earth's crust.)

FIRST PAN AMERICAN CONSULTATION ON GEOGRAPHY. *The Geographical Review,* January 1950. (Discusses the consultation held in Rio de Janeiro, September 12 to 24, 1949.)

SHORAN—APPLICATION TO GEODETIC TRIANGULATION. J. E. R. Ross, *The Canadian Surveyor,* January 1950.

THE OBLIQUE GNOMONIC PROJECTION. Norman Pye, *Empire Survey Review,* January 1950. (Demonstrates how the theory of the oblique case of the gnomonic projection can be explained along lines that are concise and yet at the same time demand for their understanding no more than the simplest plane geometry and trigonometry.)

NEW TABLET FOR SURVEY MONUMENTATION. Douglas L. Parkhurst, *The Military Engineer,* January–February 1950. (Describes a new survey marker used by the Coast and Geodetic Survey.)

CIVIL ENGINEERS CAN FURTHER AIMS OF UNITED NATIONS. Ernest E. Harvard, *Civil Engineering,* February 1950. (Directs attention to what the civil engineer can do to advance the purpose of the United Nations.)

RECONNAISSANCE AIR MAPPING:—Operational Methods of Mapping With Sparse Ground Control. Lyle G. Trorey, *Photogrammetric Engineering,* March 1950. (Describes methods used in air survey operations, film processing and printing, ground control, and the compilation of topographic maps.)

BOOKS AND PAMPHLETS

ROUTE SURVEYING. C. F. Meyer, *International Textbook Co.,* Scranton, Pa. 1949. 300 pages, illus., diagrs., charts, and tables. $6.00. (Designed as a reference for practicing civil engineers and as a text for civil engineering students.)

WINGS FOR THE TRANSIT. *Lockwood, Kessler & Bartlett, Inc.,* Brooklyn. 1949. (Basic principles of modern techniques employed in producing aerial topographic maps are explained.)

NEW COMPASS OF THE WORLD: A SYMPOSIUM ON POLITICAL GEOGRAPHY. Hans W. Weigert, Vilhjalmur Stefansson, and Richard Edes Harrison. *The Macmillan Company,* New York. 1949. 365 pages. $5.50. (Deals with current strategic and problem areas of the world.)

EQUAL-AREA PROJECTION FOR WORLD STATISTICAL MAPS (Special Publication No. 245, Coast and Geodetic Survey.) F. Webster McBryde and Paul D. Thomas. *U.S. Government Printing Office,* Washington, D. C. 44 pages. 1949. Fifty cents. (This publication presents the results of a project to produce a world projection for international census preparation and plottings, especially for use in the 1950 Census of the Americas.)

THE PROFESSIONAL GEOGRAPHER (The Journal of The Association of American Geographers). *Syracuse University,* Syracuse, N. Y. October 1949. 61 pages. (Contains scholarly articles, notes, reviews, and other material of permanent value to the Association.)

MAPS: Their Care, Repair, and Preservation in Libraries. Clara Egli LeGear. *Library of Congress,* Washington, D. C. 1949. (Routine processing, filing, mounting, and

repair are discussed and the practice and experience of several large map libraries are cited. The special problems presented by globes, relief models, and atlases in their baffling array of sizes are considered and useful advice given.)

ANTARCTIC CONQUEST: The Story of the Ronne Expedition 1946–48. Finn Ronne. *G. P. Putnam's Sons*, New York. 1949. 299 pages. $5.00. (Describes the expedition and its accomplishments, one of these being the delivery of 14,000 trimetrogon photographs to the Air Force for mapping purposes.)

PLANNING THE MODERN CITY. Harold MacLean Lewis. *John Wiley & Sons, Inc.*, London. 1949. Two volumes. (Presents the physical aspects of city planning.)

THE CARTA MARINA OF OLAUS MAGNUS, Venice 1529 and Rome 1572. Edward Lynam. *Tall Tree Library*, Jenkintown, England. 1949. 40 pages. $6.00. (The publication includes a reduced reproduction of the first woodcut version of this map of the countries of northern Europe, issued in 1529, and a full-scale reproduction of the smaller version engraved on copper and published by Lafreri in 1572. The monograph by Dr. Lynam is the first detailed commentary upon the map to appear outside Scandinavia.)

—A. A. STANLEY

DISTINCTIVE RECENT MAPS

Routes of United States and foreign airlines are traced on the map *Trans-Atlantic Operations of Scheduled Airlines as of July 1, 1949*. Numbers following the airline code initials on each route represent the number of one-way flights per week. The map was prepared by the Foreign Air Transport Division, Bureau of Economic Regulations, U. S. Civil Aeronautics Board. This black and white map measures 23½ by 34 inches. It carries neither scale nor grid.

Areas Characterized by Major Forest Types in the United States is the title of a map issued in 1949 by the Forest Service, U. S. Department of Agriculture. It is based on information from the National Survey of Forest Resources. The map measures 24½ by 39 inches and is at the scale of 1:5,000,000. Ten forest types are distinguished by contrasting color symbols for western United States, and nine for the region east of the one hundredth meridian. Reserved, non-commercial, and non-typed areas are also indicated.

The new *Devils Tower National Monument Quadrangle*, published by the U. S. Geological Survey, is of especial interest to geologists and geomorphologists. The unique physiographic feature, known as the Devils Tower, is located west of the Black Hills in Crook County, Wyoming. The tower rises to a height of 1,280 feet above the level of Bell Fourche River, and some 865 feet above its own base. Geologists are not in agreement as to the origin of this elevated mass. Most likely explanation is that the molten material from below lifted the overlying layers of sedimentary rock and formed several such domes as Devils Tower. The shaft as it now stands may be hardened lava that was once the neck of an old volcano.

This quadrangle, published in 1950, is available in shaded relief and contour editions. Within the borders the map measures 17½ by 20½ inches. The scale is 1:48,000.

Paul Bunyan, Davy Crockett, Buffalo Bill, and Jesse James are among the many interesting characters pictured on the map of *American Folklore and Legends* by John Dukes McKee. It was prepared to illustrate *Living in Our America* published in 1949 by Scott, Foresman and Company. This gaily colored pictorial map measures 20 by 31 inches. No scale is indicated.

Indian Tribes and Trapper Trails is the title of a pictorial map copyrighted in 1949 by James F. and Evelyn Gardiner of Manhattan Beach, Calif. R. W. Rodgers is the

cartographer. The map includes all the area west of the Mississippi River and the present states of Illinois and Wisconsin. It is artistically drawn on simulated hide stretched on a frame of birch branches. A number of sketches decorate the map. Some of the more important Indian tribes and trapper trails of the old west (early 19th century) are shown. The map measures 16 by 21 inches. No scale is given.

Administrative divisions, roads, and railroads are shown on the *Mapa de la República del Ecuador,* published in 1948 by Sección Estudios, Dirección General de Obras Públicas of Chile. Reproduction is by the Instituto Geográfico Militar. Clearly delimited is the boundary line established by the Rio de Janeiro Conference of January 29, 1942. There are inset maps of international and domestic air routes and of the Galápagos Islands. Within the borders the map measures 35 by 33 inches. The scale is 1:1,000,000.

The northern sheet of a projected two sheet map of French Guiana, *Carte de la Guyane Francaise,* has recently been acquired by the Library of Congress. At the scale of 1:500,000, the map shows generalized topography, river systems, swamps and forest cover, as well as a variety of cultural features.

The map was designed and published in 1949 by l'Institut Géographique National, Ministère des Travaux Publics et des Transports (France).

The French Ministère de l'Agriculture, Service d'Études et de Documentation, has issued a new map showing *Les Systèmes de Culture de la France.* It was prepared under the direction of P. Vandamme. The map shows graphically the major types of land utilization, with principal crops, based on the census of agriculture for the year 1937. The diverse character of French agriculture is evident in the patchwork of colors and symbols. The island of Corsica is shown in an inset. The scale is 1:1,400,000 and the dimensions 27½ by 30½ inches.

The railroad network of France is clearly shown on the new *Carte Schematique des Chemins de Fer Francais* recently published by Librairie Chaix of Paris. Different symbols indicate five classifications of railroads. Distances between stations are given in kilometers. The map is in color and measures 27 by 27 inches. No scale is given.

A new linguistic map of Switzerland, *Carte Linguistique de la Suisse,* has been prepared by Henri Frey, and published in 1949 by Kümmerly and Frey at Berne. It is at the scale of 1:500,000 and measures 17½ by 27 inches. Contrasting colors show areas where German, French, Italian and Romansh languages predominate. Minorities within the major regions are indicated by colored squares, circles and triangles. The map is inserted in *Geographica Helvetica,* Vol. 4, No. 4, 1949, with an accompanying commentary by Aldo Dami.

The Library of Congress has recently acquired a new political map of Luxembourg at the scale of 1:100,000. It bears the title *Grande Duché de Luxembourg* (Groot Hertogdom Luxemburg). Boundaries of states, districts, and cantons are shown, as well as roads, railroads, water features, and forested areas. The map measures 40 by 27½ inches. It was published at Brussels, Belgium, by R. De Rouck.

The Army Map Service issued, in 1949, a reproduction of the map *U.S.S.R. and Adjacent Areas* originally prepared by the British Geographical Section, General Staff, in June 1948, (GSGS No. 4625, AMS No. 5104). At the scale of 1:8,000,000, the map shows generalized relief by altitude tints. Political boundaries are shown, but the legend bears the note that "this map must not be considered an authority on the delimitation of international boundaries." Within the borders, the map measures 29 by 44 inches. On the verso there is an extensive index listing "town and village," "water feature," and "land feature" names. U.S.S.R. names are transliterated according to a modification of the system of the Permanent Committee on Geographic Names (British). Subsequent editions will be in accordance with the system of the U. S. Board on Geographic Names.

The physical framework of the *Union of Soviet Socialist Republics* is portrayed in a new physiographic diagram compiled and drawn by Don Schroeder of the University of Washington. The map was published in 1949 by Pacific Books, Inc., Palo Alto, Calif. Mr. Schroeder's sketching technique is similar to that employed on physiographic maps by A. K. Lobeck and Edwin Raisz. The map of the U.S.S.R. measures 17 by 27 inches and is at the scale of 1:12,750,000.

Economic maps of Poland and the U.S.S.R. have recently been published by the Direction de la Documentation, Secrétariat Général du Gouvernement (France). The former (*Carte Economique de la Pologne*) at the scale of 1:1,250,000, shows, by graphic and color symbols, mineral resources, industries, canals and rivers, dams, highways, railroads and centers of settlement. Small inset maps show (a) forest cover and soil conditions, (b) power stations and network, and weather stations, and (c) fishing and commercial ports.

The *Carte Economique de l'Union des Republiques Socialistes Sovietiques* is at the scale 1:10,000,000 and shows similar data for the Soviet Union. It also includes graphs showing comparative production of coal, petroleum, electricity, cereals, and sugar beets for the years 1913, 1928, 1938, and 1950 (projected). Proportions of social groups for 1913 and 1939 are also indicated on graphs. The breakdown is by "workers and employees," "free peasants," "bourgeoisie and large land owners," and "others" for 1913. On the 1939 graph, "collective farmers and artisans attached to cooperatives" replace the "bourgeoisie." The Soviet map was prepared under direction of Charles Guy. Measurements for both maps are 21 by 33 inches.

Latest in the attractive and useful series of National Geographic maps is *Africa and the Arabian Peninsula*, which accompanies the March 1950 number of the *National Geographic Magazine*. In addition to Africa and the Arabian Peninsula the map includes all of the Mediterranean countries and waters and the Near East nations. The Cape Verde Islands and a physical map of Africa are on insets. The new map of Africa includes the results of aerial and ground surveys made by many countries during and since World War II. Comparison with the Society's 1943 map of the continent reveals a number of political changes. The map measures 28½ by 31½ inches and is at the scale of 1:12,000,000.

Les Concessions Petrolieres du Moyen-Orient is the title of a recent map published by Direction de la Documentation, Secrétariat Général du Gouvernement (France), and printed by l'Institut Géographique National. Concessions for 23 separate petroleum companies are delimited on this black and white map. Oil wells, refineries, pipelines (existing, projected and in construction) and principal railroads are also included. The map is at the scale of 1:8,000,000 and measures 18½ by 15½ inches.

A *Geological Map of Malaya* was published in 1948 by the Geological Survey Department, Federation of Malaya. It measures 33 by 24 inches and is at the scale of 1:750,000. Formations ranging in age from Carboniferous to Recent are shown. Unexplored areas are left uncolored. The Langkawi Islands are shown on a small inset map.

The New Hebrides Archipelago *Archipel des Nouvelles-Hebrides* is shown at the scale of 1:500,000 on a two-sheet map issued in 1949 by the Institut Géographique National (French), Ministère des Trauvaux Publics et des Transports. Relief of the separate islands is portrayed by shading and elevation figures. Roads, trails, temporary and permanent water courses, and inhabited places are shown. Sheet 1, which includes the title, measures 38 by 27½ inches, and sheet 2 is 26½ by 32 inches.

——Walter W. Ristow

Books in Review

YOUR LAND—SURVEYS, MAPS AND TITLES (Engineering Experiment Station Series Bulletin No. 71). Fred C. Morris. *Virginia Polytechnic Institute*, Blacksburg, Va. 1949. 95 pages. $0.75.

Reviewed by S. A. Bauer, Surveyor, Cleveland, Ohio.

In this booklet, Professor Morris covers in simplest terms the fundamentals of geodesy, plane rectangular coordinates, the more common of the projections, notations on computations, and considerable data on the various uses of aerial photographs. Although all these points have been covered in many existing books and texts on surveying, this particular document differs primarily in its simple, lay phraseology. Professor Morris includes also a chapter on land titles by registration, discussing, among other things, the Torrens Title system. The author is to be complimented on the many very clear photographs and illustrations accompanying the work.

This publication deserves wide distribution among practicing surveyors, in order that they may become familiar with some of the more advanced phases of surveying, which are stated in fairly nontechnical language, understandable to every practitioner.

The opening chapter of the booklet, entitled "Status of Land Surveys," pictures a desperately low level of surveying procedure, which is undoubtedly applicable to certain limited sections, but should not be applied to the average progressive practitioner throughout the country. It is unfortunate that Professor Morris has not indicated that the status of surveys that he outlines is specifically limited in its practice to isolated regions, and does not represent the over-all status of surveying. The Technical Standards for Property Surveys, adopted by the American Congress on Surveying and Mapping in 1946, represent a level of surveying so far removed from the level Professor Morris describes that there is little basis of comparison. It is further unfortunate that general adoption of the nationally recognized standard of practice developed by the Congress (as represented by the Technical Standards for Property Surveys) is not cited as the solution to the standardization of surveying procedures.

On the other hand, it is well that the entire document is phrased in a manner that is understandable to all. It is to be hoped that the demand for Professor Morris's bulletin will be so great as to require a reprinting, in which Professor Morris might well supplement his opening chapter as suggested herein.

HANDBOOK FOR AERIAL MAPPING AND PHOTOGRAMMETRY. Lyle G. Trorey. *Cambridge University Press*, New York, N. Y. 1950. 178 pages, 78 illustrations. $5.00.

Reviewed by G. C. Tewinkel, Chief, Research Section, Division of Photogrammetry, U. S. Coast and Geodetic Survey.

Dr. Trorey's book is a handbook in a true sense of the word—it contains concise descriptions, definitions and examples of the phases, terms, and problems encountered in photogrammetric mapping. It is a text for the beginner inasmuch as the treatment is elementary and a previous knowledge of the subject is not assumed. Crisp definitions are conveniently separated by wise paragraphing and frequent topic headings. The many illustrations are effective and well prepared. The book is also a handy reference text for the more advanced photogrammetrist. Equations are stated where they are needed, but derivations are intentionally omitted. Approximate equations are stated in addition to the exact forms in several instances where the simplification is useful. The formulas are illustrated by means of numerical examples.

The first chapter briefly describes the principles of perspective sufficiently complete to form a basis for the rest of the book. Three chapters are devoted to the oblique photograph, which is described in detail as a useful tool in photo-interpretation and map compilation. Parallax, elevations, and stereoscopy with vertical photographs are treated at some length. Determining heights from both vertical and oblique photographs, for which detailed instructions are given, is one of the outstanding topics. The radial-line methods are described in detail and illustrated, including the use of the spring-loaded intersection locator. Rectification as related to automatic rectifiers and anharmonic rectifiers (sketchmasters, camera lucidas) is discussed briefly. Stereoscopic plotting instruments are described and explained with principal emphasis on the multiplex. The procedure of relative orientation is outlined, but the text is not intended to be a complete and detailed handbook for multiplex operation. Some photogrammetrists may disagree with the author's high rating of the relative accuracy of multiplex mapping.

The mapping procedures of the author's organization are described, indicating the various steps involved, such as ground control, aerial photography, map compilation, editing, drafting, and reproduction.

The language is what one might expect of a military manual, which facilitates the use of the book. Naturally, Canadian and British photogrammetric terms are used throughout, which cause little difficulty for the American reader inasmuch as the terms are well defined. For example, y-parallax is called "want of correspondence" and is symbolized by the letter K.

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Waldseemuller Map

ONE OF THE MOST important world maps in existence may come to the Library of Congress to be exhibited as a treasure comparable with the Vollbehr Bible. Until recently, it belonged to Prince Franz Joseph II of Liechtenstein.

The date of this cartographic treasure is 1507. It was the second map to bear the name America as applied to the half of the planet discovered, or at least rediscovered, by Christopher Columbus 15 years earlier. The artist responsible for the chart was Martin Waldseemuller, a scholarly clergyman at St. Die in the Vosges Mountains of France. With a colleague he collated geographical data at Strasbourg and Basel. This material he used in writing a little book entitled "Cosmographiae Introductio," or "Introduction to Cosmography."

To illustrate the text he "compiled" a large map of a dozen wood blocks which, in assembled form, gave a tolerable idea of what the earth was supposed to look like. Waldseemuller printed "America" in the region of South America. He did this in honor of Amerigo Vespucci of Florence, who had written a series of descriptions of the lands of the Western Hemisphere and perhaps actually had explored some of them.

As many as 1,000 copies of Waldseemuller's book and map were sold. Thus he was encouraged to bring out other publications, among the number the smaller chart which the Prince of Liechtenstein is now selling and which the Library of Congress hopes to obtain. This latter map is gored for application to a globe. It inspired the globular map of Gerhard Mercator which appeared in 1538 and clinched the name America for the New World. Meanwhile, Waldseemuller had changed his mind about honoring Amerigo Vespucci and deleted his reference to him from subsequent charts. But his efforts to correct his mistake were too late to be effective. The discoveries of Columbus are labeled in tribute to a much less important person—the financial representative of Lorenzo de' Medici, whom Hendrik Van Loon considers only "a clever publicity man."

If the gored map comes to the Library of Congress, the whole story will be told again in detail. It makes one of the truly sardonic pages of universal history.—*Washington Evening Star*, May 27, 1950.

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession. —EDITOR.

Topographic Maps

THE FOLLOWING list of topographic maps, published during the first 6 months of 1950, has been compiled from the official lists of New Publications of the U. S. Geological Survey, Numbers 498 to 503. These maps are available with or without the green overprint which indicates woodland. Those marked by a dagger are available in either a contour or a shaded-relief edition. All maps are 7½-minute quadrangles, except those marked with an asterisk, which are 15-minute quadrangles.

Maps of areas east of the Mississippi River may be ordered from the Chief of Distribution, U. S. Geological Survey, Washington 25, D. C., and of areas west of the Mississippi River from the Distribution Section, U. S. Geological Survey, Denver Federal Center, Denver, Colo.

Alabama

Brundige*
Columbia City
Grove Oak
Henagar
Hollywood
Painter
Wannville

Alabama-Tennessee

Eureka 95-NW

Arizona

Black Mt.
Bowie*
Crozier Peak
Paulden*
Putnam Wash
Rockinstraw Mt.*
Saddle Mt.
Sheridan Mt.*
Turkey Canyon*
Winkelman

Arkansas

Abbott
Charleston
Waldron*†

California

Bidwell Bar
Carmichael
Chico
Coloma
Fiddletown
Hayward
Latrobe
Llanos Seco
Monson
Nelson
Nevada City
Oakland East
Ord Ferry
Oregon House
Orange Cove N
Parker Dam Area*
Polvadero Gap*
Rackerby
San Clemente Is. Central
San Clemente Is. N
San Clemente Is. S
San Francisco S
San Miguel Is. W
San Miguel Is. E
Santa Catalina E
Santa Catalina N
Santa Catalina S
Santa Catalina W
Searles Lake*
Stanislaus
Temecula
Traver
Tustin
Wahtoke

Colorado

Anderson Mesa
Arvada
Buttes
Cascade
Cheyenne Mt.
Colorado Springs
Corral Bluffs
Elsmere
Falcon NW
Fort Lupton
Fountain
Fountain NE
Fountain SE
Hamm Canyon
Horse Range Mesa
Littleton
Manitou
Mount Big Chief
Mount Pittsburg
Platteville
Timber Mt.

Connecticut

South Canaan

Florida

Ankona
Arlington
Boca Raton
Bradley Junction
Caryville
Delray Beach
Delta
Eastport
Eden
Glades

Goose Island
Greenacres City
Homestead
Indrio
Jupiter
Mayport
New Inlet
Palm Beach
Palm City
St. Lucie Inlet
South Miami
Trout River

Georgia

Claxton*
Cusseta
Glennville*
Hinesville*
Limerick*
Meldrim*
Midland
Pembroke*

Georgia-Alabama

Columbus
Fort Benning

Idaho

Idaho Falls South
Parker
St. Anthony
Woodville

Illinois

Aurora North
Danville NW
Danville SW
Dwight*
Springfield E
Springfield W

Illinois-Iowa

Milan
Port Byron

Indiana

Belmont
Edinburg*
Elkinsville
Franklin*
Gosport
Henryville
Lewisville
Mitchell
Morgantown
Newcastle E
Shoals

Kansas

Basehor
Easton
Erie*
Jarbalo

Kansas-Missouri

Mulberry*

Kentucky-Virginia

Ewing

Maine

Kingsbury*
Old Orchard Beach
Portland East
South Harpswell
York Beach
York Harbor

Maine-New Hampshire

Kittery

Maryland

Libertytown
Perryman
Spesutie

Maryland-Delaware

Pittsville

Maryland-West Virginia

Kitzmiller
Oakland

Minnesota

Aurora
Belle Prairie*
Cushing*
Embarrass
Lastrup*
Little Falls*
Pierz*
Swanville*

Missouri

Augusta*
Bucklin NW
Durham
Elkton
Ferrelview
Fredericktown*
Lexington E
Lexington W
Mayview
Maywood
Meta*
Nashua
Odessa N
Palmyra
Philadelphia
Rothville
St. Patrick
Sumner
Tavern*

Missouri-Iowa

Wayland

Missouri-Kansas

Liberal
Platte City

Missouri-Oklahoma

Seneca

Missouri-Oklahoma-Kansas

Racine

Montana

Dent Bridge*
Johnson Lake

Nebraska

Bingham*
George Lake*
Hire*
Lakeside*
Linscott*
Longfellow Lake*
Mumpher*
Spade Ranch*
Spring Valley*
Storm Lake*
Thedford*
Twin Lake*

Nevada

Ione*
Paradise Peak*
Wheeler Peak*

New Hampshire

Crawford Notch*†

New Jersey

Asbury Park
Bound Brook
Cape May
Farmingdale
Freehold
Hightstown
Jamesburg
Lakewood
Marlboro
Mendham
Monmouth Junction
Point Pleasant
Stone Harbor
Wanaque
Wildwood

New Jersey-New York

Sandy Hook

New Jersey-Pennsylvania

Trenton West

New York

Albany*
Bay Shore E
Bay Shore W
Bellport
Clarence
Clarence Center
East Aurora
East Hampton
Fort Niagara
Gardiners Island E
Gardiners Island W
Gasport
Greenport
Hicksville
Howell Point
Jones Beach
Jones Inlet
Lancaster
Lawrence
Lewiston
Lloyd Harbor

Lockport
Mattituck Point
Montauk Point
Napeague Beach
Newfane
Niagara Falls
Orient
Patchogue
Quogue
Ransomville
Sayville
Sea Cliff
South Hampton
Southold
Troy*
Wolcottsville

New York-Connecticut

Mount Kisco

North Carolina

Buxton
Cape Hatteras
Concord
Green Island
Hatteras
Howard Reef
Nakina
Okracoke
Pine Bluff
Portsmouth
Slocomb
South Pines
Vander

North Dakota

Brantford NE
Burlington
Des Lacs
Manfred
Manfred NW
New Rockford
Renville
Simcoe
Vanville NE
Westhope SW

Oklahoma

Hulbert*
Keefeton*
Wagoner*

Oregon

Ochoco Reservoir*

Pennsylvania

Austin
Birdsboro
Conrad
Crosby
Hazelton
Langhorne
Lees Fire Tower
Marshlands
Morris
Nuremberg
Oleona
Scranton
Shenendoah
Tamaqua
Weatherly
Wharton
White Haven
Wildwood Fire Tower

Pennsylvania-New Jersey

Beverly
Bristol

South Carolina

Bethera
Bradley
Bulls Island
Capers Island
Charleston
Fort Moultrie
Galivants Ferry
James Island
Johns Island
Kaiwah Island
Kirksey
Kittredge
Ladson
Legareville
Melgrove
Nichols
Sewee Bay
Wando

South Dakota

Highmore
Highmore SE
Ree Heights
Ree Heights SE
Vayland
Vayland NW

Tennessee

Campbell Junction 108-SW
Clarkrange 108-NE
Columbia
Dorton
Isoline
Obey City 108-NW
Orme 94-SE
Palmer 99-SE
Sinking Cove
Tracy City 99-SW
White City 100-NW
Whitwell 100-NE

Tennessee-Kentucky

Mingo Mountains 144-SE

Tennessee-Virginia

Coleman Gap 161-SW
Kyles Ford 170-SW
Looneys Gap 179-SW

Texas

Bastrop*
Cedar Bend
Clawson
Elgin*
Frankston*
Goldthwaite*
Huntington
Lufkin
Platt
Redland
Smithville

Utah

Aspen Grove
Bridal Veil Falls
Orem
Provo
Spanish Fork
Springville
Timpanogos Cave

Virginia

Broadway*
Cape Charles
Catlett
Charleston
Cheriton
Clinchport 188-NW
Dillwyn*
Duffield 179-NE
Elliots Creek
Messick
Middleburg
Stafford
Strasburg*†
Townsend
Westcott Point
West Point
Yorktown

Washington

Grand Coulee Dam*
Haas*
Hunters*
Lincoln*
Mount Christie*
Mount Steel*
Starbuck*
The Brothers*
Turtle Lake*
Wilbur*
Wilmont Creek*

Wisconsin

Deer Park*
Downing*
Ladysmith*
Stone Lake*
Weyerhauser*

Wisconsin-Minnesota

Grantsburg (Wis. only)*
Webster*

Wyoming

Amend Ranch
Campbell Hill
Careyhurst
Gilbert Lake
Glenrock NW
Glenrock
Hylton Ranch
Jewel Springs
Orin
Orpha
Parkerton
Prairie View School
Pratts Soda Lake
Shawnee
Sundquist Ranch

Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR

THE SPIRIT THAT IS MAKING THE CONGRESS

After receiving your letter, a copy of your paper, and a card of application, I am immediately applying for membership.

Your paper gives me great confidence in some of the points I am stressing in my effort with our Association. While Manitoba is very advanced in the matter of monumenting old corners whenever work is done concerning them, in Ontario very little authoritative backing of such monumenting is done.

I live and work in an area some 12 square miles in extent where practically the whole city and its environs were all original grants, in blocks or tracts, from the Six Nations Indians to owners, from about 1800 on. When the first township block survey was made, the lines stopped at the tract lines. So we are constantly up against the problem in legal work of determining or establishing the old tract lines. Practically none of the original monuments are in existence or have been permanently marked.—SHIRLEY KING, Brantford, Ont., in a letter to S. A. Bauer.

SAMUEL W. MILLER, JR.*—I am a new member of the American Congress on Surveying and Mapping, and have found the two copies of the Journal which I have received most interesting and informative. As chief of the Channel Engineering and Mapping Section of the local Corps of Engineers office, I am interested in all of the aims of the Congress, but being a land surveyor at heart I am particularly interested in property surveys and I hope the Journal will have many articles concerning the problems of the land surveyor.

Surveying has come of age in the last 15 years; however, I feel the average surveyor has not been able to take advantage of the great progress that has been made because of lack of organization. To me the American Congress on Surveying and Mapping and the State Association are the answer to that problem, and I assure you of any help I might possibly render in this part of the country.

* President, Virginia Association of Surveyors, Inc.

Publication Dates of Surveying and Mapping

The "off-the-press dates" for The Journal are the last month of a particular quarter or the early part of the first month of the next quarter. For example, the July–September issue is due during the last week of September or the first week of October.

CONGRESS NEWS

Secretary's Report

(Presented at Tenth Anniversary Meeting, June 23, 1950)

PRESIDENT BAUER and members of the Congress, this is the Tenth Anniversary Meeting. It constitutes the growth of our Congress after nine full years of operation.

I will try to give you a brief resumé of the minutes of the meetings since the Ninth Annual Meeting, and it will be in two parts, since we were operating from July through December under the old constitution and from January on the calendar year basis adopted at the last Annual Meeting.

High lights of the work accomplished in the four formal board and executive meetings are as follows:

First, approval and adoption of the principles and recommendations for EQUITABLE FEES FOR PROPERTY SURVEYS as proposed by the Property Surveys Division and as published in the Journal;

Second, activation of the very important management committee on finance and budget;

Third, adoption of bylaws for the Control Surveys Division of the Congress, and adoption of their proposed STANDARDS FOR HIGHWAY SURVEYS;

Fourth, activation of the important Public Relations Committee;

Fifth, activation of the Advisory Council;

Sixth, reactivation of the Division on Topographic Surveying and Mapping, and adoption of their constitution; and

Seventh, expansion of the Membership Commitee activity on a broad basis in keeping with its vital importance to the Congress.

In the second part, from January 1, 1950, to date, the high lights are:

First, appointment of officers and committee chairmen for the year, and their confirmation;

Second, groundwork for incorporation of the Congress, which will be in the District of Columbia, and which will be officially completed at this meeting;

Third, adoption of a carefully prepared budget, and operation under its governing control;

Fourth, prosecution of nominating and balloting procedures for the election of officers under the constitution;

Fifth, prosecution of all matters pertaining to the Tenth Anniversary Meeting;

Sixth, review of the proposed constitution and bylaws of the Property Surveys Division for adoption, which was completed at this meeting; and

Seventh, formal acceptance of A. C. S. M. as a member of the National Research Council, and the appointment of a representative member to the Council, a matter, I believe, now pending final approval of that body.

In a more general way, it is to be noted that the profession of surveying and mapping is slowly beginning to be recognized. In this recognition, we are proud

to say that A. C. S. M. has played no small part. Much activity is noted in various states concerned with the organization of surveyors in behalf of their profession.

Active bodies known to us are: The Los Angeles section of A. C. S. M.; the Georgia Association of Registered Land Surveyors, an institutional affiliate; the Virginia Association of Surveyors; the Maryland Society of Surveyors; the North Carolina Society of Surveyors; the Missouri Association of Land Surveyors; and the Illinois Registered Land Surveyors Association.

Formative activity is noted in Alabama, Connecticut, Florida, Long Island, and Montana. Strong interest by engineering societies is evidenced in New Hampshire, New Jersey, and the State of Washington.

The U. S. Census Bureau now recognizes surveying as a professional endeavor, and has notified President Bauer of the change in classification over the former listing as semi-professional.

Similar viewpoint is being evidenced by the Civil Service Commission, by its whole-hearted cooperation in matters pertaining to recent standards for Cartographic Aide and Cartographic Engineer series concerned with position classification.

The National Academy of Science has recognized surveying and mapping by accepting A. C. S. M. into membership of the National Research Council.

The Society has been represented at professional meetings, such as the Michigan Society of Registered Land Surveyors, Lansing, Mich.; the Canadian Institute of Surveying and Photogrammetry, at Ottawa; and the Corporation of Quebec Land Surveyors, at Montreal, by President Bauer.

The Congress was represented by Mr. W. S. Massa, of Chattanooga, Tenn., at the dedication of Perkins Hall, a new engineering building of the University of Tennessee, in March.

Mr. Jon Beazley, A.C.S.M.'s advisory counselor from Florida, represented us at Tallahassee, in Florida, at the April meeting of the Florida Engineering Society.

Now, a short report on membership. Membership is the lifeblood of the Congress. The following figures are of vital interest, since all of you are members-at-large in the membership activity.

I would like to remind all of you who were at the dinner last night here that the Countess Pulaski gave a little skit on the typical meeting of a women's club. I will refer to that a little later.

First, the operational budget of the Congress for 1950 is balanced on a potential of 1,500 paid individual members, individual members paid up for 1950. Building that membership to 1,500 individuals is the goal of your membership committee, and you are all urged to do your bit to reach that target.

Now for just a few figures. The June 1st active plate list total shows 1,625 active plates. Deduct 190 library, 10 exchange and 12 sustaining members, a total of 212, and that gives you 1,413. That is the active individual member count. Deduct 226 new paid members since the Ninth Annual Meeting, and it gives you 1,187 for the old membership, active as of June 1st.

Now, we deduct 261 of the old membership not yet paid for 1950, and that gives you 926 of the old membership paid for 1950. Putting that a little differently, that is, 20 percent of the old membership is not paid for 1950. Add those 226 new members paid to that 926, and that gives us 1,152 paid members for 1950.

That means, gentlemen, that some 348 individual paid dues are required for 1950 to meet that budget target of 1,500, from either the 261 old members not yet paid or from new members.

I now ask you to recall "Countess Pulaski's" skit on the typical ladies' society last night. Many of you folks who heard that recall where the committee chairman got up and said they had some 182 members, and hemmed and hawed a little bit and then finally broke down and said there were 15 or 20 of them that had paid dues.

After hearing Senator Malone's description of placing the Nevada land corner, I feel that the surveyors and mappers do rate a bit more professional ruggedness than the Countess' ladies' society, and perhaps show a better percentage of paid-up members.

Any way you look at it, there is a lot of work to be done, and all of you fellows out there can be a big help in getting some of it done. Do your bit. Get a new member.

WALTER S. DIX
Secretary

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Editor's Report

(Presented at Tenth Anniversary Meeting, June 23, 1950)

FIRST, I would like to report on the present status of the Journal. Since our last meeting, four issues have been published—unavoidably at slightly irregular intervals. For the balance of this year we are in a very favorable position. Practically all the material that we have on hand has been processed and is either at the printers or in galley form. This, together with the reports of this meeting, will be sufficient for the next two issues of the Journal. These should be off the press the first week in October and the first week in January, respectively.

I think it may not be amiss on this Tenth Anniversary Meeting to note briefly what we have accomplished thus far through the medium of our Journal.

I have here the first issue of SURVEYING AND MAPPING, published in January 1943. It is an 8-page leaflet and is called the "Bulletin of the American Congress on Surveying and Mapping." This was a modest beginning, but it marked a milestone in the history of the Congress because it symbolized the reactivation of its affairs, which had been dormant for nearly 2 years.

The next 3 years saw progressive improvements in both content and design, and in January 1946 we published the first Journal in an enlarged format with a new cover design, and we called it SURVEYING AND MAPPING. This issue contained 96 pages in contrast to the 8 pages of 3 years before. We have maintained this form to the present time.

A few brief statistics should be of interest, particularly to those who are comparatively new in the Congress. Between 1943 and the present we have published 1875 printed pages of material. Among these were 206 original articles that covered such subjects as Cartography, Property Surveys, Topographic Surveys and Maps, Control Surveys, Instrumentation, and Education for Surveying and Mapping. Seventy articles were also reprinted from other publications and dealt with similar or related subjects.

In addition, 547 articles and 212 books and pamphlets were briefly digested in our Current Literature Department; 118 distinctive recent maps were described; 25 surveying and mapping books were comprehensively reviewed; and about 438 items of a miscellaneous nature were published.

What does all this add up to? It is this: Through our Journal we are developing an authoritative literature in a field that never before had an exclusive medium of expression in this country. Judging by the many letters we have received from individuals and institutions both in this country and abroad, our Journal is being used as a source of reference for the newest developments in the fields of surveying and mapping. This, I think, is the great contribution the Journal is making to the profession.

So it is with a measure of pardonable pride that I look back over these past years.

I wish to express my thanks specifically to Mr. Helmuth Bay and his Publications Committee for the fine cooperation given me in the preliminary edit of material; to authors and contributors for their time and patience in preparing articles; and generally to others who have had a part in the work of preparing the Journal for publication.

Finally, I would like to say that for myself it has been a privilege to be associated with the Congress through all these years and to watch the infant flower to almost full maturity. It gives one a feeling of satisfaction to know that he has contributed, even though only in a small way, to the ideals and objectives to which we are dedicated. I hope the Congress continues to grow and grow and grow.

A. L. SHALOWITZ
Editor-in-Chief

Membership Committee Report

(Presented at Tenth Anniversary Meeting, June 23, 1950)

THIS REPORT covers only the latter part of the past year, for the reason that it has been only within recent months that I have had this job thrust upon me. I will tell you briefly what we have done during that period, what the results have been thus far, and finally how each of you members can help the committee meet its responsibility for enlarging the membership and thereby increasing the prestige and effectiveness of the Congress.

As indicated by Mr. Bauer, sending out sample copies of our quarterly Journal has been the principal line of attack in efforts made in the past to increase the membership. This has been productive, but the number of prospects who can be reached by this procedure is quite limited, since the cost of the Journals plus the cost of mailing them make the method entirely too expensive when thinking in terms of the thousands of people interested sufficiently in surveying and mapping to be considered as prospective members.

After analyzing the situation and the funds allotted for membership work, our committee decided that we would adopt a general policy of broadcasting information about the Congress on a "mass production" basis at low unit cost. We started out by preparing a leaflet for each of the technical divisions. Each leaflet directs attention to some of the outstanding articles and other items that have

appeared in previous issues of the Journal. The leaflets, accompanied by a brief statement of the objectives of the Congress and an application blank attached to a business reply envelope, constitute the material now being sent out in relatively large quantities. Reprints of some articles and some complete Journals are also sent out in special cases.

I must admit that I was somewhat dubious, at first, as to how effective the new program would be. But I am now convinced that it will prove to be a reliable method of steadily increasing our membership. Although it has been in operation for less than 3 months, it has produced approximately 100 applications for membership. Furthermore, we are learning from resulting correspondence that the information we send out is arousing general interest that is certain to result eventually in adding new members who are somewhat hesitant about returning an application immediately.

Experience with the plan thus far also has shown that individual members of the Congress can, with very little effort on their part, assist materially in obtaining new members by furnishing the Membership Committee, Box 6244, Washington 15, D. C., with the names and addresses of persons whom they would like to see become members of the Congress. Also, experience has shown that there is an occasional member who has seen the possibilities of the program and has volunteered to take over the distribution of material to a certain group of people for a certain area, for example, the surveyors listed in the classified telephone directory of a city.

Since the names of prospects are taken from numerous lists, registers, etc., by different members in different parts of the country, there is bound to be some duplication; also, some of our perfectly good members are certain to receive literature inviting them to join the Congress. When this happens to a member he should, instead of feeling that "the organization does not know who its members are," send the material to someone he thinks ought also to be a member.

As the program proceeds it becomes more and more apparent that we must enlarge and broaden our Journal. Applicants for membership are influenced to join by their interest in the titles of articles and the items shown on the leaflets sent out, and they naturally expect each Journal to carry articles and items of similar nature. Here again is where our members can help appreciably by contributing articles, photographs, new methods, short cuts, special tables, suggestions, poetry, etc., that they feel will help to stimulate interest in the only publication in the United States devoted 100 percent to surveying and mapping.

Copies of the leaflets and other material mentioned will be sent to any member upon request.

FRANK S. BORDEN
Chairman

PROTECTION

"Why does the editor call himself 'we'?

"So the fellow who doesn't like what he says will think there are too many of him to lick."—*Army and Navy Journal.*

Resolutions Adopted at Tenth Anniversary Meeting

The following Resolutions were unanimously adopted by the American Congress on Surveying and Mapping at the Tenth Anniversary Meeting at Washington, D. C., June 23, 1950.

RESOLUTION OF COMMENDATION TO THE INTER-AMERICAN GEODETIC SURVEY

WHEREAS, the Inter-American Geodetic Survey is collaborating with 17 countries of the American Hemisphere in extending precise geodetic control surveys over an area of 18,000,000 square miles maintaining standards of accuracy having international recognition, be it therefore

RESOLVED, that the American Congress on Surveying and Mapping express its commendation to the Inter-American Geodetic Survey for the progress that has been made in the execution of the surveys and recommend that this international cooperation be continued so that continental datums may be established for vertical and horizontal control and that projection systems be adopted which will be suitable for the extension of local surveys, and be it further

RESOLVED, that the copies of this resolution be forwarded to the directors of the cartographic organizations of the collaborating countries, the U. S. Secretary of Defense, the U. S. Secretary of the Department of the Army, and the Commanding Officer of the Inter-American Geodetic Survey.

RESOLUTION ON SURVEYING AND MAPPING OF THE UNITED STATES

WHEREAS, accurate maps and charts are required for national defense and for the adequate development of natural resources, and

WHEREAS, such maps and charts are necessary for safe air and sea navigation, and

WHEREAS, such maps and charts are necessary for many other purposes such as flood control, reclamation projects, highway development, delineation of Federal, state, and property boundaries, for all Federal, state, and urban planning, and numerous other uses both governmental and private, and

WHEREAS, a bill to provide an accelerated program for surveying and mapping of the United States, its territories and possessions, and for other purposes, has been presented to the Congress of the United States (Senate Bill S2989 and House of Representatives Bill HR6900), be it therefore

RESOLVED, that the American Congress on Surveying and Mapping endorse these bills and strongly urge their adoption, and be it further

RESOLVED, that copies of this resolution be forwarded to the committee on Interior and Insular Affairs, the Armed Services Committee of the United States Senate, the Committee on Public Lands, and the Armed Services Committee of the United States House of Representatives.

RESOLUTION TO ACTIVATE A TECHNICAL DIVISION ON EDUCATION

WHEREAS, the constitution of the American Congress on Surveying and Mapping provides that "Professional or technical divisions may be formed at the discretion of the Board of Direction, and may be organized to deal with each of the various fields of interest or activity of the Congress," be it therefore

RESOLVED, that the Board of Direction consider and establish a new division on Surveying and Mapping Education.

(This resolution was offered in the form of a motion from the floor and was passed.)

RESOLUTION ON THE TENTH ANNIVERSARY MEETING

WHEREAS, the Tenth Anniversary Meeting of the American Congress on Survey-

ing and Mapping, being about to complete a most successful and interesting series of meetings, notes with approval the marked advance in the techniques of surveying and mapping made within the last decade, and the increased interest in improving the standards of the surveying and mapping profession, be it therefore

RESOLVED, that the American Congress on Surveying and Mapping express its appreciation to all those who have contributed their time and effort to the furtherance of this advance and these improvements, and be it further

RESOLVED, that the Congress express its appreciation to each of those who have contributed to promoting and arranging a most successful meeting, and be it further

RESOLVED, that the Congress note with pleasure the attendance of representatives of the various nations of the Americas and invite their continued interest and participation in the affairs and meetings of the Congress.

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The President Reports

MICHIGAN SOCIETY OF REGISTERED LAND SURVEYORS

The Ninth Annual Meeting of The Michigan Society of Registered Land Surveyors was held at Michigan State College, in East Lansing, Mich., on February 17 and 18, 1950.

Your president, an invited guest of the organization, arrived on the second day of the meeting. He was warmly welcomed by W. B. Williams, president of the Society and member of the advisory council of the Congress, as well as by G. D. Henning, secretary, and also a member of the Congress. Several old friends, including John Goggin, and new friends, soon made your president feel that he was a part of the group. Your president was asked to speak on the general subject of the American Congress on Surveying and Mapping. By this time, your president, no orator, can speak at length and without notes on that subject. At this meeting, your president recounted the various steps in his experience with professional surveying organizations, from the first small, local organization through the state organization, and finally to the Congress. He indicated the problems, as well as the accomplishments, of the Congress and praised the Michigan Society of Registered Land Surveyors, and like organizations, as being essential to the ultimate aims of the Congress. That, in substance, was your president's talk to the association.

The business meeting that followed took up the matter of the adoption of the TECHNICAL STANDARDS FOR PROPERTY SURVEYS of the ACSM, which discussion ended in a favorable ballot. A number of interesting papers were read.

Prof. C. M. Cade spoke on the uses of the optical theodolite; Mr. Robert Clark gave a talk on the history of the U. S. Land Survey; Mr. Talbert Abrams spoke on the importance of aerial mapping to the land surveyor. In addition, Mr. Abrams provided an interesting film, "Around the World with Kodachrome," taken by Mr. and Mrs. Abrams on a recent extended trip around the world. Mr. F. N. Bateman gave a short talk on property survey problems; Mr. Marcus Shaaf gave a talk on the retracement of U. S. Land Survey corners; Mr. D. L. MacElroy gave a talk on the submission of plats for records; Prof. C. W. Barr read a paper on the subdivision of lands from the city planning viewpoint.

At the close of the meeting, your president, on request of individuals and the secretary of the society, gave out his entire supply of application blanks for membership in the Congress.

The Michigan Society of Registered Land Surveyors gives evidence of being a healthy, flourishing assembly of practicing surveyors, among whose number is the only woman surveyor operating her own office and doing her own field work who is known to your president. The Michigan Society is to be complimented on the dignity of its deliberations.

The ever-growing list of such state organizations, and the requests for information as to the workings of such state organizations, is an encouraging sign that the property surveyors of this country are becoming alert to the renaissance taking place in their midst.

The Michigan Society forms a very good pattern for other state organizations yet to be formed.

MEETING OF QUEBEC LAND SURVEYORS

The 67th Annual Meeting of the Corporation of Quebec Land Surveyors was held in Montreal on April 19 and 20, 1950. It was attended by your president upon invitation from George Coté, president of the Corporation.

The welcome extended to the Congress through your president was of such warmth and graciousness that it is difficult to portray. The colorful and bilingual city of Montreal cooperated with the Corporation to make the meeting of greatest interest. In addition to papers and moving pictures on surveying matters, the morning of the 19th was spent in a visit to the City Hall, particularly the engineering and city planning departments, concluded by a visit with the mayor of the city, and finally a meeting in the council chambers. This meeting was presided over first by retiring president George Coté, then by the new president, Henri Belanger, and finally by his honor, the mayor himself. The mayor, acting as genial host, provided a cocktail party for the visitors, although he limited himself to coffee.

The meeting of the Corporation was attended by many old friends of the Congress, as well as many members. President Coté was most flattering in his description of the activities and value of the American Congress on Surveying and Mapping, and requested application blanks for his members.

The most remarkable feature to your president of his visits to Canada is the high prestige that the profession commands in that country. That prestige is the result of many years (in Quebec Province 67 years, in the Dominion 43 years) of organizational activity within the profession.

A surveyor is an important man in Canada, and a land surveyor apparently the most important. It was a subject of great surprise to Surveyor General Bruce Waugh that your president is actually a land surveyor—"one of us," he said.

It is encouraging and heartening to view the benefits that long years of organization within the profession have accomplished. The Congress can do much worse than to follow the pattern of integrated organizational activity that exists in Canada. It is the hope of your president that a few more years of activity on the part of the Congress will benefit our profession at least in some measure on a comparable basis.

CITY COLLEGE OF SAN FRANCISCO AND THE PROPERTY SURVEYOR

One of the first conclusions of the Property Surveys Division of the American Congress on Surveying and Mapping was the need to stimulate college courses in property surveying to the fullest extent. The publication of the TECHNICAL STANDARDS FOR PROPERTY SURVEYS and the Fee Study of the Division have stimulated several short courses in various institutions.

The latest, and one of the most encouraging of such developments, is a course instituted by the City College of San Francisco, under the guidance of Mr. C. J. Aggeler. Mr. Aggeler is using as a basis for his course a syllabus prepared by our well-known member, Mr. William C. Wattles, chairman of the Property Surveys Division, and a member of the Advisory Board of the Congress. This syllabus deals at considerable length with the various problems of property surveying, but specifically with "Description and Survey in Title, California Land Titles."

The City College of San Francisco is conducting a 2-year terminal curriculum in surveying and map drafting. In this curriculum part of the work is in land surveying, using Mr. Wattles' syllabus, in a large measure, as the text. Mr. Aggeler now proposes to begin a course to be called "Property Description and Conveyancing" to be run concurrently with field work in land surveying. Mr. Aggeler augments his course with visits to the assessor's and recorder's offices in San Francisco and in San Mateo County, where the routine of searching records and acquiring information is investigated.

It is encouraging to hear of the spread of training in property surveying in the colleges of this country. The City College of San Francisco, and Mr. C. J. Aggeler in particular, are to be congratulated upon this contribution to the betterment of the age old profession of land surveying.

—S. A. BAUER

Admiral Studds Heads Coast and Geodetic Survey

On May 16, 1950, Rear Admiral R. F. A. Studds assumed office as the fourteenth Director of the U. S. Coast and Geodetic Survey, succeeding Rear Admiral Leo Otis Colbert.

Admiral Studds brings to his new office the experience derived from a distinguished career in the Survey, which he has served ever since 1919, following his release from military service in World War I. A native of Washington, D. C., Admiral Studds attended the Catholic University of America, from which he graduated in 1917 with the degree of Bachelor of Science in Civil Engineering. Brief employment with the District of Columbia Engineering Division and service with the 472nd Engineers, U. S. Army, constitute the only portion of his professional career outside of his work with the Survey.

His service has included field work in all of the areas lying within the responsibility of the Survey; command of several Survey vessels, and a tour of duty as officer in charge of the important San Francisco field office. Just before his appointment as Director he served briefly as chief of the Division of Charts.

Admiral Studds has long been a member of the American Congress on Surveying and Mapping and is an enthusiastic supporter of its objectives.

NEW MEMBERS

INDIVIDUAL MEMBERSHIPS

ANDERSON, C. EDWIN, Civil Engineer and Surveyor, 66 Vernon St., Springfield 3, Mass.

BALDWIN, MAURICE E., Surveyor, 877 N. Perry St., Pontiac 16, Mich.

BARAHONA, FERNANDES, JOSE A., Lt. Comdr., Casa Do Norte, R. dos Combatentes, S. Pedro do Estoril, Portugal

BAUSCH, CARLTON E., Surveyor, 43 Patten Ave., Oceanside, Long Island, N. Y.

BEARDSLEY, MARION C., 295 N. 23rd St., Salem, Oreg.

BLACK, ROSCOE J., Land Surveyor, 201 Montague St., Caro, Mich.

BLANCHET, JOS., Q.L.S., 72 Ste Ursula St., Quebec City, Que., Canada

BONHORST, LEONARD W., Engineer, Box 39, U.S. Bureau of Reclamation, Redfield, S. Dak.

BOYD, MORRIS J., Civil Engineer, 13108 S.E. Cora St., Portland 66, Oreg.

BOYD, R. P., Consulting Engineer, 21½ S. Barstow, Eau Claire, Wis.

BREHMER, HERBERT H., Civil Engineer and Surveyor, Suttons Bay, Mich.

BUCK, ROSS W., Sanitary Engineer, U. S. Public Health Service, 605 Volunteer Bldg., Atlanta, Ga.

BURGESS, FRANKLYN T., Engineer and Surveyor, 330 Walnut St., Manistique, Mich.

CANOVA, CARLOS FENWICK, SR., Engineer and Surveyor, Canova Beach, R.F.D., Melbourne, Fla.

CASSISTA, ANDRE, Q.L.S., 111 Mountain Hill, Quebec, Canada

CASTRO, ALBERTO G., Ing., Ave. Miraflores 215, Barranco, Lima, Peru

CHANCE, JOHN E., Field Engineer, Sun Oil Co., P. O. Box 1083, Houma, La.

COOKE, R. J., Registered Land Surveyor, 210 N. Adams St., East Tawas, Mich.

DEHLINGER, MARTIN EMERY, 1101 Eleventh Pl., Big Spring, Texas

DERR, C. W., General Map Co., 401 Merrill Ave., Rockford, Ill.

DILL, HENRY, Land Surveyor, 189 Montague St., Brooklyn, N. Y.

DONAGHUE, JOHN P., County Surveyor, Box 65, Webster, Wis.

ELLIOTT, ROBERT T., Civil Engineer, 4029 Gilmore Ave., Cincinnati 9, Ohio.

FETTERS, BEVAN D., Route 5, Celina, Ohio

GRAVEL, JACQUES, Q.L.S., 14 Fabric St., Quebec, Que., Canada

HAWKINS, IRVIN J., Engineer, U. S. Geological Survey, Box 133, Rolla, Mo.

HERD, LLOYD O., 1067 W. 2nd Ave., Columbus 12, Ohio

HICKS, HERBERT S., Surveyor and Engineer, 1416 Granger, Ann Arbor, Mich.

HUBBELL, CLINTON C., Civil Engineer and Surveyor, 124 Perry Ave., Norwalk, Conn.

HUBBS, GEORGE L., Engineer, Planning Division, State Roads Commission, 315 Professional Bldg., Charleston 1, W. Va.

KELLY, GEORGE R., Engineer, 6435 Fairfax Rd., Apt. 22, Chevy Chase, Md.

KINCH, MACK, Surveyor, Box 205, Urbana, Ill.

LA BARRE, LEONARD LUKE, Surveyor, P. O. Box 95, Thompson, Pa.

LAWSON, JAMES M., District Engineer, Box 133, U. S. Geological Survey, Rolla, Mo.

LEE, EUGENE M., Lt. Col., Supervisor, Survey Section, Observation Dept., Tactical Artillery School, Ft. Sill, Okla.

LINCOLN, WM. M., Registered Surveyor, 1437 National Bank Bldg., Detroit 26, Mich.

LOONEY, J. P., Assistant Chief, Photographic Branch, U. S. Navy Hydrographic Office, Washington 25, D. C.

LOWRY, ROBERT W., Engineer, Vice President, Capitol Engineering Co., Church St., Dillsburg, Pa.

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